STUDENTS' PRACTICAL GUIDE TO

in Search of Science 2

Russell
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Mayfield

SI EDITION

in Search of Science

STUDENTS' PRACTICAL GUIDE TO BOOK 2

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in Search of Science, Book 2
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Contents

Date	Working as a Scientist	Exercise

Science is concerned with attempting to describe and explain our environment, and with applying the knowledge which has been gained. The first stage is observation. All scientific knowledge is based on careful and complete observation of the facts.

Observe and record

How well do you observe?
Look at your pencil and make five observations about it. Then record your observations in a list:

1.
2.
3.
4.
5.

You will make your own records in this guide to practical work. What will you do to make this a good record? Suggest some important features of a good record:

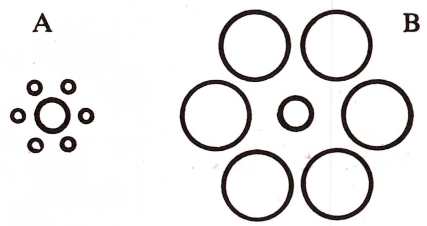
1.
2.
3.

Did you include *completeness* and *order*?

Now think about the way in which you observe. In every observation we use our senses. What senses do you use to gather information about:

the colour of a rose
the scent of a rose
an aeroplane flying overhead at night
the surface of an object
the food on your plate?

Are your senses always reliable?
Which is larger, A or B?



How could you check your judgment?

Do this. Were you correct?

In this case you used a measuring instrument (a ruler) to make your observations precise. Often this must be done. What would you use to help you observe
a tiny object
the planet Mars?
Often your observations will need to be checked by being repeated, and your results may suggest further observations or experiments.

Experiments

Every experiment you do is an enquiry or investigation. It begins with a problem or question. You may need apparatus to help you set up the necessary conditions, and to make measurements. Finally, you should record *all* your results, observations and conclusions.

Apparatus

You may be given a set of apparatus to use throughout the year. On a separate sheet of paper, make a list of the pieces of apparatus available. Draw a plan of the storage cupboards showing where each piece can be found.

Using chemicals

Chemicals are used in definite amounts and always in *small quantities*. We use drops to measure liquids. Practise dropping water from your teat pipette. As a measure for solids, we will use a *spot*. Wherever you read 'use one spot of . . .', use enough material to cover this

Many chemicals, both solid and liquid, will burn, stain or irritate your skin. Some could poison you! They are safe only if used in the right way. Treat them with respect. Find out the answers to these questions and write them in:

What should you do if

1. you spill an unknown liquid?

2. you spill an unknown powder?

3. the test tube you are about to use is dirty?

4. the experiment you perform leaves the apparatus dirty?

Using the burner

The flame of the burner is often very hard to see, and can cause accidents. Complete the table by suggesting a sensible way of avoiding each problem.

Accident	*Way of avoiding it*
burnt sleeves	
burnt tie	
burnt hair	
burnt shelf or wall	

Most of these accidents occur when the burner is alight but *not in use.*

Suggest a good way of

1. telling whether the burner is alight

2. shielding the flame from passing objects

The most dangerous thing in the laboratory

You! Think about your behaviour in the laboratory, remembering that your job there is one of honest enquiry. Then fill in the table at the foot of the page.

If you have followed this exercise carefully you will have learnt some of the methods of scientists; you have started to make your own records; and you have made a commonsense set of rules.

Have these checked—and follow them.

	Comment and reason
moving about in the laboratory	
trying out a few quick mixtures on your own	
talking (think carefully about this)	
making notes	
the way you leave your apparatus and work area	
entering the laboratory without a teacher	
eating in the laboratory	

Date	The Effects of a Catalyst	Exercise
Materials	burner test tubes splint	manganese dioxide potassium chlorate

Procedure

A. A source of oxygen

1. Place 1 cm of potassium chlorate in a test tube. Heat it *gently* and lower a glowing splint into any gas above the potassium chlorate.

   What happens?

2. Heat the test tube *strongly*. Notice the bubbles in the potassium chlorate, and lower a glowing splint into the gas above the molten potassium chlorate.

   What happens this time?

   What happened to the potassium chlorate when it was heated strongly? What were the bubbles of gas formed?

B. Action of catalyst

3. Measure out another 1 cm of potassium chlorate and tip it onto a piece of paper.

4. Measure out half this amount of manganese dioxide. Add it to the potassium chlorate and mix them together. **(Do not grind)**

5. Place this mixture in a test tube and heat it *gently* and lower a glowing splint into the test tube. What happens?

   Notice that the mixture remains solid. In the first part of the exercise the potassium chlorate was molten when giving off the oxygen. What does this suggest about the temperature at which the oxygen was evolved in each case?

   The manganese dioxide in this reaction is said to be a catalyst and it enables this reaction to proceed at a lower temperature. What can you say about the rate at which oxygen is given off in each case?

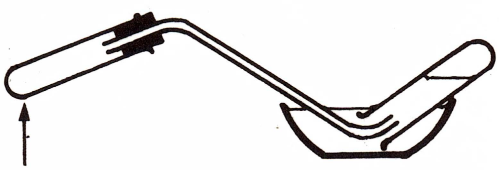
   Design a simple experiment in which you could *measure* the rate at which the oxygen is given off in each case.
   If your design is sound and you perform the experiment, you will be able to show that a catalyst speeds up the reaction.

Date	A Preparation and some Properties of Oxygen	Exercise
Materials	test tubes delivery tube splint corks for test tubes burner	evaporating dish 25 cm^3 flask and stopper oxygen mixture 5 cm magnesium ribbon

Procedure

A. Preparation and collection

1. Half fill the evaporating dish with water.
2. Fill a test tube with water and invert it in the dish ready for use.
3. Place 1 cm of oxygen mixture in a test tube and attach the delivery tube.



4. Light the burner and heat the mixture *gently* by moving the test tube above the flame.
5. Allow about the first 50 bubbles of gas to escape.
6. Place the collection test tube over the outlet of the delivery tube. When the test tube is full of oxygen, cork it.
7. Stand this test tube in the rack and fill two more test tubes in the same way (leave 1 cm of water in one of these), and then fill the 25 cm^3 flask in the same way.

B. Colour and odour

8. Use one sample and observe the colour and odour.

colour

odour

C. Solubility in water

9. Shake the tube containing oxygen and 1 cm of water and invert it under water and remove the cork. Observe any rise in level. What does this tell you about the solubility of oxygen in water?

How do your results indicate that displacement of water is a satisfactory method for collecting oxygen?

Do your results match your knowledge of the solubility of oxygen in water? Explain your answer in two or three short sentences.

D. Combustion

10. Place a *lighted* splint in a test tube of oxygen.
    What happens?

11. Hold the piece of magnesium ribbon in a pair of tongs, ignite it and lower it into the flask of oxygen. (Avoid looking directly at the flame).
    What happens?

    From the last two observations, comment on the effect of oxygen on the rate of combustion.

Date	Metals and Non-Metals	Exercise

Materials			
	test tubes burner conductivity apparatus "lead" from a pencil copper wire	samples of: zinc magnesium carbon iron	sulphur lead mercury phosphorus copper

Procedure

1. Examine samples of the elements provided. Notice any shine (lustre) and colour. If necessary, scratch the samples with your spatula. Record your observations in the table on the next page.
2. Place one spot of zinc in a test tube and heat it for a few seconds. (A spot is a piece this size ●)

Does it melt readily?

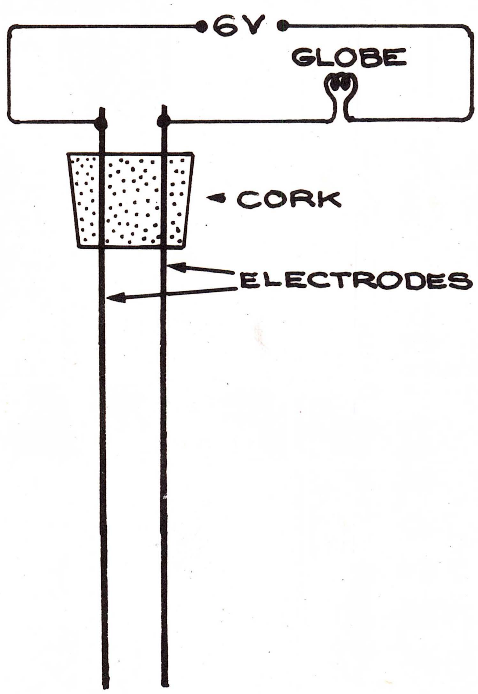
Classify this and the other elements as having a high or low melting point and record results.

3. Repeat procedure 2 with the other elements.

Note: for phosphorus use only ½ spot, cover it with water and heat it.

Omit phosphorus from the remaining procedures.

4. Connect a conductivity apparatus set to 6 V D.C. and touch the two electrodes together to test the globe. The globe should light up.
5. Arrange samples of the elements in order on the tile.
6. With the current switched on, touch each element with the two electrodes. Classify the conductivity of each element as high or low and record this in your table.



7. Strip the "lead" from a pencil. The "lead" is a form of carbon called graphite.
8. Hold the graphite rod in one hand and a piece of copper wire in the other. Place one end of each above a bunsen flame.

The ______ is a better conductor of heat than the ______

9. Place a spot of lead, copper and roll sulphur on a hard surface such as the base of a retort stand. Tap each sample with a hammer.

Comment on the malleability or brittleness of each element.

These examples show that metals are whereas non-metals are

Element	*Lustre (high or low)*	*Colour*	*Melting point (high or low)*	*Conductivity (high or low)*
zinc				
magnesium				
carbon				
iron				
sulphur				
lead				
mercury				
phosphorus				
copper				

Generalization

metal				
non-metal				

Date	# Indicators	Exercise

Materials	hydrochloric acid sodium hydroxide nitric acid sulphuric acid potassium hydroxide calcium hydroxide lemon juice saliva tile	litmus solution methyl orange phenolphthalein ammonia solution sodium chloride solution sour sob juice filtered soil and water universal indicator

Procedure

1. On a clean dry tile place 3 separate drops of dilute hydrochloric acid.
2. Repeat with 3 separate drops of water and 3 separate drops of sodium hydroxide solution.
3. To one drop of each set add 1 drop of litmus and record your results in table I.
4. To another set add 1 drop of phenolphthalein and to the third set add 1 drop of methyl orange. Record your results.

TABLE I

Indicator	*Colour with*		
	Hydrochloric acid	*Water*	*Sodium hydroxide*
litmus phenolphthalein methyl orange			

5. Place 3 drops of each of the following solutions on the tile and add a drop of each of the indicators as previously—dilute nitric acid, dilute sulphuric acid, potassium hydroxide, ammonia solution, calcium hydroxide (lime water).
6. Record your results in table II.

TABLE II.

Solution	*Colour produced with*		
	Litmus	*Methyl orange*	*Phenolphthalein*
nitric acid sulphuric acid potassium hydroxide ammonia solution calcium hydroxide			

7. On the basis of your results, complete the more general table III.

TABLE III			
Indicator	*Acid colour*	*Intermediate colour*	*Alkaline colour*
litmus			
phenolphthalein			
methyl orange			

8. Use one or more of the indicators to test and classify the given solutions as acidic, "neutral" or alkaline.

Solution	*Classification*
sodium chloride	
lemon juice	
sour sob juice	
saliva	
garden soil	
(Shaken with water)	

Date	Classification of Oxides— Reactions with Water	Exercise

Materials			
	9 dry test tubes litmus solution teat pipette	small samples of: sodium calcium magnesium iron (steel wool)	lead copper sulphur phosphorus (red) carbon

Procedure

A. Heating metals to form oxides

1. Place a *small amount* (one spot ●) of freshly cut sodium in a *dry* test tube and heat it gently.
2. Allow the test tube to cool on the asbestos mat.
3. Heat one spot of calcium in a similar way and allow it to cool.
4. Repeat this with other metals. Be sure that you either label the test tubes or arrange them in the known order in which you do them.
5. Using a pipette, add 1 cm of water to the residue in each test tube.
6. Add 2 drops of litmus solution to each test tube and record your results in the table.

B. Heating non-metals to form oxides

7. Rinse the pipette several times with water.
8. Place a small amount of sulphur in a dry test tube and heat it.
9. Hold the wet pipette in the test tube and puff moist air in and out of it. This will enable fumes to be absorbed.
10. Allow the test tube to cool and then add 1 cm water. Use this to wash out the inside of the pipette, and return all of the liquid to the test tube.
11. Add 2 drops of litmus solution to the liquid in the test tube, and record your results in the table.
12. Wash the pipette carefully before proceeding to the next element.

Element	*Appearance of product after heating*	*Effect on litmus*	*Nature of oxide*
sodium			
calcium			
magnesium			
iron			
lead			
copper			
sulphur			
phosphorus			
carbon			

13. Repeat this procedure using red phosphorus and then carbon, making sure you record your results in the table after each step.

C. Summary of conclusions

The oxides which dissolved in water affected the litmus solution.

Those which dissolved to form alkaline solutions were the oxides of

Those which dissolved to form acid solutions were the oxides of

Date	Classification of Oxides— Reactions with Acids and Alkalis	Exercise

Materials

- test tube
- zinc oxide
- lead monoxide
- calcium oxide
- magnesium oxide
- copper
- iron oxide
- copper oxide
- marble chips
- sodium sulphite
- teat pipette

Procedure

A. Metallic oxides

1. Place one spot of zinc oxide in a test tube, add 3 drops of dilute nitric acid and warm gently. (Spot = ●)
   What happens to the zinc oxide?

   This is not a process of solution. A chemical reaction has occurred.
2. Repeat this with each of the other oxides and record your results by placing a √ in the table if a reaction occurs.
3. Place one spot of zinc oxide in a test tube, add 3 drops of sodium hydroxide solution and warm gently.
   What happens to the zinc oxide?

4. Repeat this procedure using the other oxides listed.
   Place a tick in the table if a reaction occurs.

Oxide	*Reaction with acid*	*Reaction with alkali*
zinc		
lead		
calcium		
magnesium		
iron		
copper		

Oxides of metals react with
and are classified as *basic oxides*.

B. Non-metallic oxides

5. Place the tip of the pipette in water, expel 10 bubbles of air and release bulb. Note how far the water level rises and notice that the water remains steady at this level. You will use this for a comparison shortly.
6. Place 2 cm sodium hydroxide solution in a test tube.
7. Generate carbon dioxide in another test tube by adding a few drops of dilute hydrochloric acid to some marble chips. Fill the pipette with carbon dioxide gas.
8. Lower the pipette into the sodium hydroxide solution, expel 10 bubbles of carbon dioxide and then release the bulb. Observe carefully and comment on the level of liquid in the pipette.
   (1) immediately.

   (2) after a minute or two.

   What suggests that a reaction occurs between the carbon dioxide and the alkali sodium hydroxide?

9. Place 2 cm of sodium hydroxide solution in a test tube.
10. Generate sulphur dioxide in another test tube by adding 3 drops of concentrated hydrochloric acid to sodium sulphite in a test tube. Fill the pipette with sulphur dioxide gas and repeat procedure 8.
11. Record your results by placing √ in the table if a reaction occurs.

Oxide	*Reaction with nitric acid*	*Reaction with sodium hydroxide*
carbon dioxide		
sulphur dioxide		
nitrogen dioxide		

Oxides of non-metals react with ______ and are classified as *acidic oxides*.

12. Repeat procedure but instead of using sulphur dioxide use the gas nitrogen dioxide. This is prepared by adding 3 drops of dilute nitric acid to a copper pellet in a test tube. Record your results.
13. Repeat the whole procedure with carbon dioxide, sulphur dioxide and nitrogen dioxide but use dilute nitric acid instead of caustic soda solution.

Date	Using the Microscope	Exercise
Materials	microscope prepared slide	

Procedure

1. Three common types of microscopes are shown in the photographs. Examine the one you will use and compare it with those shown.
2. Place the smallest *objective* lens in position. In type C turn the eyepiece in an anti-clockwise direction as far as it will go.
3. Look through the eyepiece and adjust the position of the mirror so that you can see a clear even circle of light.
4. Place the slide to be examined on the stage.

Type A.

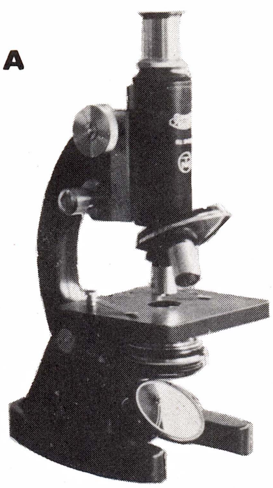
5. *Look from the side* and turn the *coarse adjustment away* from you until you have lowered the objective lens to about 0·5 cm.
6. *Look into the eye piece* and turn the *coarse adjustment towards* you slowly until the material on the slide comes into focus
7. To increase the magnification turn the other objective lens into position. Once you have done this adjust the focus by using the *fine adjustment only.*

Types B & C.

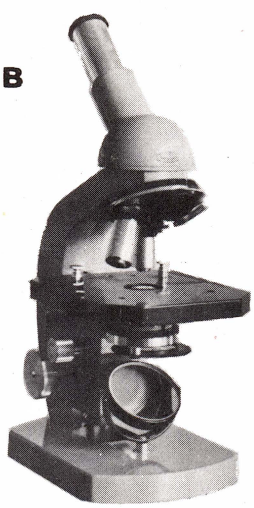
8. Turn the *coarse adjustment towards you* as far as it will go.
9. Look into the eye piece and turn the *coarse adjustment* away from you slowly until the material on the slide comes into focus.
10. Type B as for type A.

    Type C. Turn the eye piece in a clockwise direction adjusting the focus as you do this.

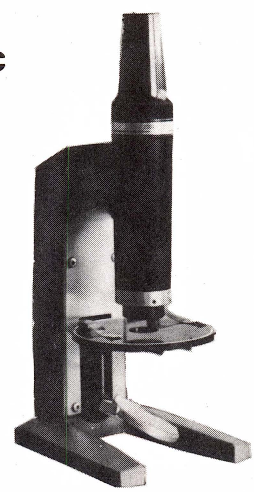
A



B



C



Date	Cells	Exercise
Materials	microscope forceps 2 microscope slides scalpel or razor blade coverslips mounted needle	teat pipette toothpick absorbent paper stain (iodine or methylene blue) piece of onion bulb

Procedure

A. To study plant cells

1. Place a drop of water in the centre of one slide.
2. Hold the piece of onion in your hand, break it, and peel off a small piece of the transparent epidermis Fig. (a).

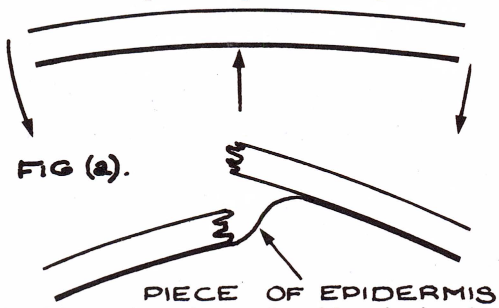


FIG (a).

3. Place the piece of epidermis in the water on the slide and use the razor blade to cut it if the piece is larger than 1 cm square.
4. Lower the coverslip over the material and examine it using the low power of the microscope.
You are examining plant tissue. Are all of the cells similar in shape?

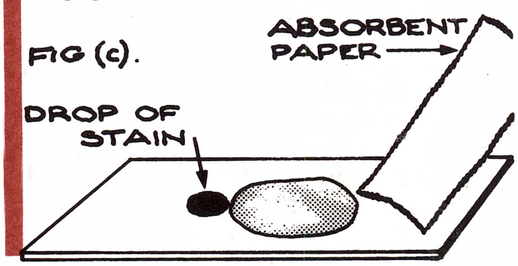
What part of the cell can you see clearly?

About how many times longer than wide are the cells?

5. Draw a group of 3 or 4 cells in the space below making sure that you draw each cell about an inch long.

6. Remove the slide from the microscope. Place a drop of stain near the edge of the coverslip and draw the stain under the coverslip by using the absorbent paper as in Fig. (c).

FIG (c).



7. Examine the slide again under low power.

   Is the cell now coloured evenly throughout?

   The rounded body which has stained most deeply is the *nucleus*.

8. Move the slide so that one cell, which has stained deeply, is in the *centre* of your field of vision. Increase the magnification and look carefully at the cell. Has anything near the nucleus become stained?

   How far does this extend?

   This stained material is the cytoplasm and the central clear part is a vacuole.

9. Include these observations in one of the cells on your original diagram.

   Keep your slide until you have completed the next part of the exercise.

B. To study animal cells

10. Place a drop of water in the centre of a clean slide.

11. Gently scrape the inside lining of your cheek with a toothpick and then dip that end of the toothpick into the drop of water. Move the toothpick so that the scrapings will fall into the water.

12. Add a drop of stain, place a coverslip in position and examine the preparation under low power. Move the slide so that 1 or 2 cells can be seen clearly.

    How would you describe these cells?

    Is each cell much longer than it is wide?

    In what position in the cell is the nucleus?

13. Move the slide so that one cell is in the centre of the field, and increase the magnification.

    Has this cell a thick cell wall?

    Where is the cytoplasm in the cell?

    How many vacuoles can you see?

14. Draw 2 or 3 cells and label all the parts you have seen.

    The onion cells are plant cells. The cheek cells are animal cells.

    What is the same about both types of cells? Check your slides again if you are not sure.

    What is different about them?

    Is this sufficient evidence for you to make a general comparison between plant and animal cells?

    If you think you need more evidence, how would you obtain it?

Date	The Mammal	Exercise

Materials

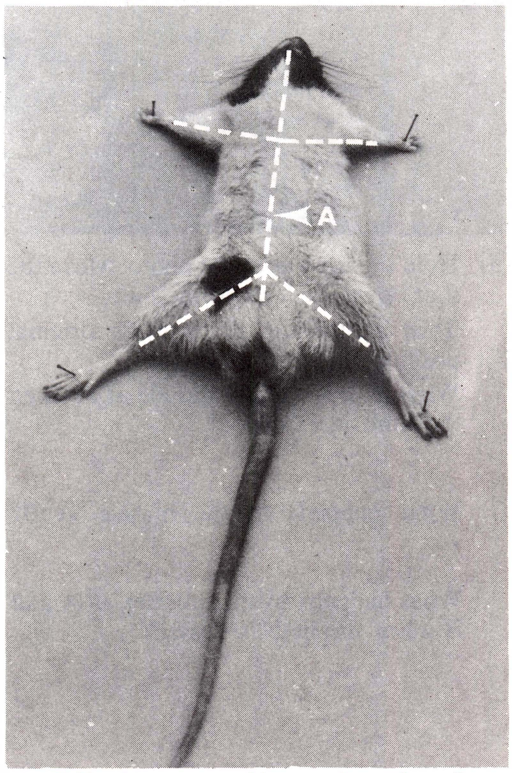
- small mammal
- dissecting board
- scalpel
- scissors
- seeker
- forceps
- dissecting pins or fine nails

Procedure

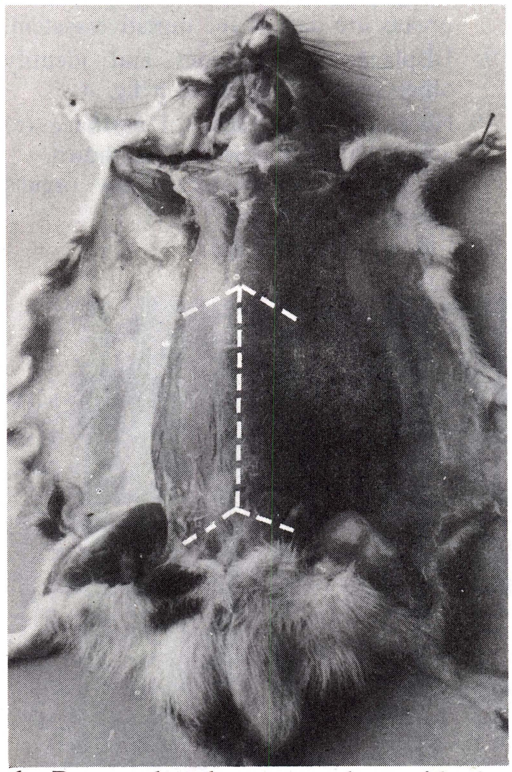
Only use scissors and/or scalpel when instructed.

Much can be learnt by using forceps and seeker.

1. Pin out the animal with the ventral side uppermost as shown.

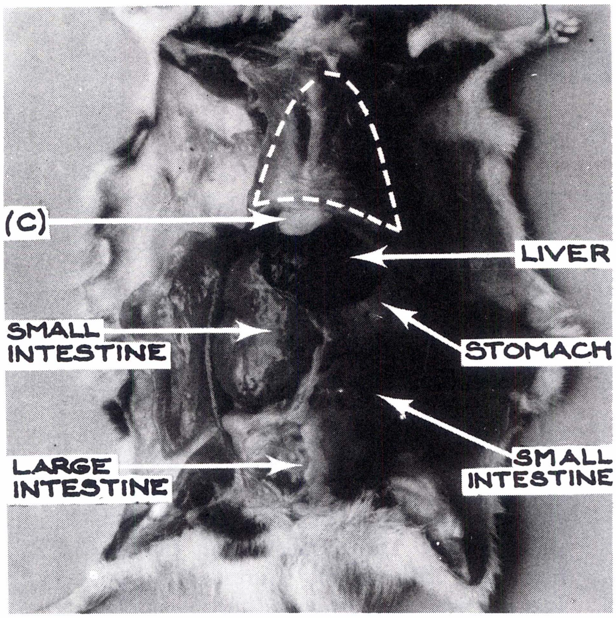


2. Lift the outer skin at A and make a small cut with scissors.
3. Using scissors cut the outer skin as indicated by the dotted line.
4. Gently ease the skin from the body wall. Where thin transparent tissue holds the skin to the muscular wall, loosen this by drawing the scalpel blade across it.
5. Pin back the skin as in fig. 2.

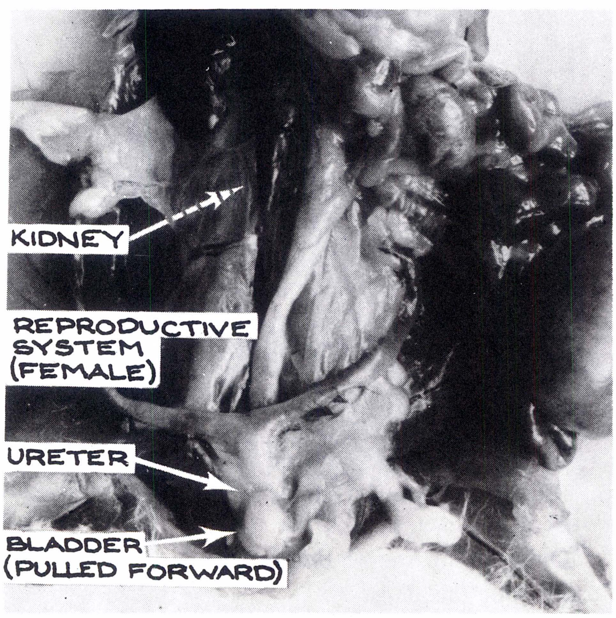


6. Repeat the above procedure with the body wall, cutting as indicated.

   Only cut up to the diaphragm.
7. Pin out the flaps.

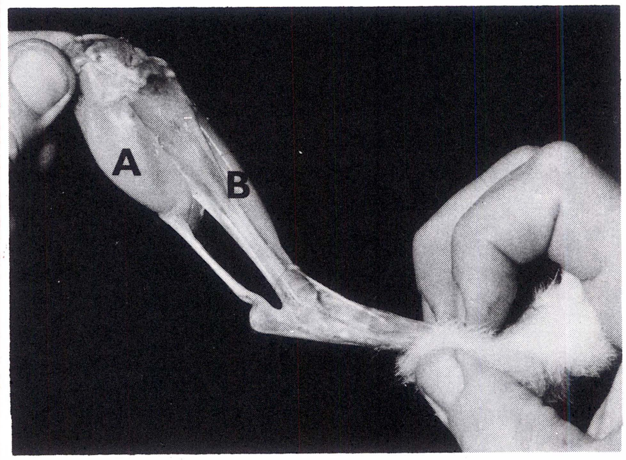


8. Without shifting any organs identify those labelled in the photograph. These organs are part of the digestive system.
9. Displace the intestines and identify other systems indicated in fig. 4.
10. Hold the small piece of cartilage (c) and cut through the ribs as shown. Be careful not to pierce any organs beneath the rib cage.
11. Lift out the rib cage.



MUSCLES OF A MAMMAL

1. Remove the skin from one hind leg of the mammal.
2. Cut through muscles above the thigh, cut through the thigh joint and so remove the limb.
3. Remove the thin membrane from around the muscles.
4. Examine carefully using your seeker to help and notice
   (1) the arrangement of muscles,
   (2) the way in which the muscles are attached to the bones.
   (3) the arrangement of tendons in the foot.



5. Hold the limb as in the photo. Move the foot down, i.e. extend the limb.

   Then return the limb to its original position, i.e. flex the limb.

   What happens to the muscle at A when the limb is extended?

   What happens to the muscle at B?

   What happens to the muscles at A and B when the limb is flexed?

6. Remove the muscles from the bones and examine the joints.

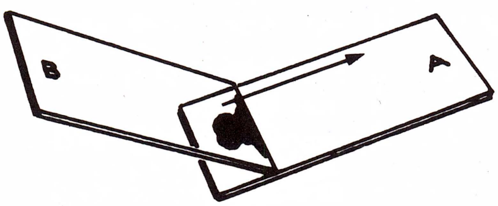
Date	An Examination of Blood	Exercise

Materials

microscope
3 microscope slides
mounted needle
filter paper
cotton wool
blood lancet (or sterile needle)
watch (minutes)
alcohol
Wright's stain

Procedure

1. Massage one finger or thumb so that more blood flows to the tip. Sterilize this with alcohol on cotton wool. Wait for the alcohol to dry.
2. Pierce the finger with a blood lancet and allow a drop of blood to fall onto slide A near the end.
3. *Immediately* place slide B into the position shown and push it *quickly* along slide A.



4. Allow slide A to dry and during this time squeeze several drops of blood onto the centre of the third slide. (If blood will not flow from the first puncture, be sure to sterilize the lancet and finger before making another puncture.)
5. Place this slide to one side and continue with the blood smear on slide A. Now that the smear is dry add 3 drops of Wright's stain and allow to stand for one minute. Then add 3 drops of distilled water and allow to stand for two minutes.
6. Drain off the stain and cover the smear with distilled water.
7. Allow this to stand and when the thinnest parts of the smear are pink, blot the smear gently with filter paper and allow the smear to dry.
8. Examine the smear under the low power of the microscope. Move the slide until you find a part in which the cells can be seen clearly.

   Increase the magnification.

   What is the shape of the many small cells you can see?

   Notice that each has a patch of a different colour in its centre. This is not a nucleus but the colour difference is due to the fact that the centre of these red corpuscles is thinner than the edges.
9. Move the slide until you see at least one large cell with its central nucleus brightly stained. This is a white cell. About how many times is a white cell larger than a red corpuscle?
10. Carefully move the slide and look for more white cells. Notice that the nuclei are quite different in some of them.

    Are the white cells more or less numerous than the red corpuscles?

    How many different kinds of white cells did you find?

Draw a few red corpuscles and two different white cells.

11. Now look carefully at the large drop of blood you put to one side.
Tilt the slide.
What do you notice?

12. The edges have probably dried out, but look for a clear coloured liquid, serum, around the drop.

13. Move the point of a needle through the drop.
What do you notice?

14. Add a drop of water to this lump of blood and wash away most of the red corpuscles.
What is left behind?

What has happened to the large drop of blood you placed on the slide?

When is this property of blood of vital importance to us?

Harvey's Experiment

Materials

you!
a large handkerchief or strong bandage

Procedure

1. Work with a partner for the first part of the exercise. Exercise your left arm and then allow your partner to tightly tie the handkerchief around the upper arm.
2. Clench your left hand.
3. Sit at your desk and rest your forearm on the desk with your palm facing upwards.
4. Notice that the blood vessels of the forearm have become more prominent. Look carefully and find small swellings along one of the prominent veins.
5. Place a finger of your right hand firmly on this vein. Move your finger along the vein towards the upper arm.
What happens to the swelling?

What do you notice when you lift your finger from the vein?

6. Now move your finger along the vein in the opposite direction.
What happens to the swelling this time?

What do you notice about the ease with which blood is moved along the vein?

The swellings represent the positions of valves in the vein. What does this exercise explain about the function of the valves?

Date	A Dissection of a Sheep's Heart	Exercise
Materials	sheep's heart (with pipes) scalpel scissors	seeker 4 wooden skewers or pieces of 1 cm dowel

Procedure

A. If lungs are attached

1. If lungs are attached examine the relation between the heart and lungs.

   Identify trachea, bronchi, lungs. Cut through one lung and notice the branches of the bronchi and the spongy nature of the lungs.
2. Pull the heart vessels from the other tissue and using your fingers remove as much fat as possible.
3. Cut the vessels about 15 cm from the heart so that you have the heart as in figure 1. Now proceed as in 4.

B. If lungs and pipes not attached

4. Identify the *auricles* and the *coronary* blood vessels (figure 1).
5. Hold the heart in your hand. Squeeze it. Notice that one ventricle feels hard. This is the *left ventricle*.
6. Place the heart on the board with its left side on your right, i.e. you are viewing it from the ventral surface. Match figure 1.
7. Now that you have identified the left and right sides, pass a wooden skewer into one of the large vessels. Probe

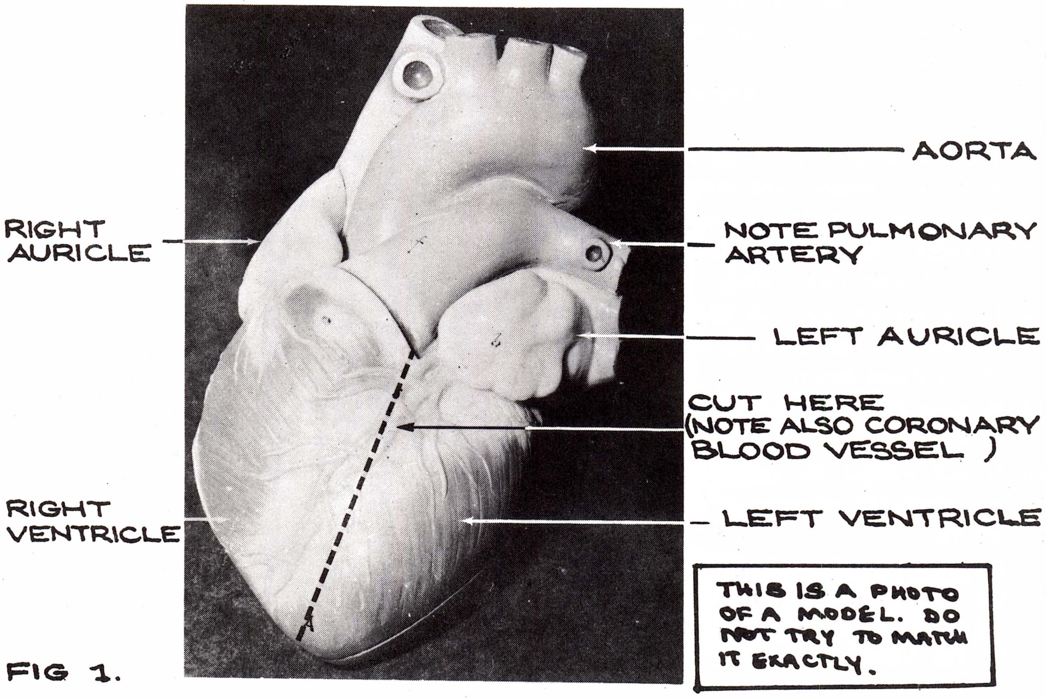


FIG 1.

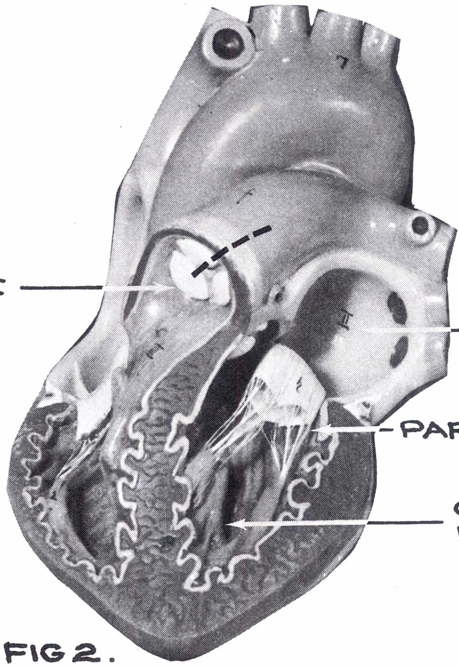


FIG 2.

with it and "feel" which ventricle it enters. In this way identify the *aorta* (left) and the *pulmonary artery* (right). Identify the *pulmonary veins* and *venae cavae*.

8. Use your scalpel to cut as shown in figure 1. Make any other cut necessary so that you can see into one ventricle.
9. Identify *auricle*, *ventricle* and *parachute valves*.
10. Place a seeker under the cords of the valve and notice how strong they are.
11. Notice where the large artery leaves the ventricle. Look for the three pocket shaped *semilunar valves*.
12. Using scissors cut this artery as shown in figure 2 and observe the semilunar valves more closely.
13. Repeat 12-14 for the other side of the heart.
14. Notice behind the semilunar valves in the aorta the opening of the coronary artery.

Copy the outline of figure 2. Mark in the chambers of the heart, vessels and valves and draw in the pathway taken by the blood.

Date	# Surface Tension	Exercise
Materials	beaker dish 2 matches wire test tube (small) filter paper	teat pipette razor blade burner copper gauze detergent

Procedure

1. Half fill the dish with water. Place the razor blade on the filter paper and, when the water is still, carefully place the paper on the water surface. What holds the razor blade on the surface?

2. Bend the copper gauze into the shape of a boat and carefully lower it on to the water surface.
3. Drop water into the 'boat' from the teat pipette. Describe what happens?

4. Half fill a test tube with water and sketch the surface in figure 1.

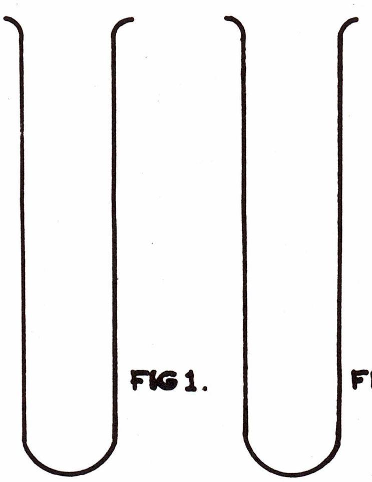


FIG 1. FIG 2.

Now fill the test tube until the water level is above the top of the test tube. Sketch the shape of the liquid surface in figure 2.

5. Watch a drop form and fall from the laboratory tap. Sketch the drop (a) as it forms, (b) just before it drops.

6. Rub the razor blade with detergent and try to float it on the water. What happens?

   Suggest a reason for this.

7. Lay two matches side by side on the surface of clean water in the dish. Touch the surface of the water between the matches with the tip of a glass rod dipped in detergent. What happens? Why?

8. Using the same water as before, replace the matches side by side. Repeat the process in 7.

   What happens?

9. Refloat the matches in *clean* water. Touch between them with a hot wire. What happens?

   What does this suggest?

Here are some statements about surface tension.

Write, in the spaces provided, the numbers of the steps, if any, which supported each statement.

(a) Surface tension in water is reduced by detergent.

(b) Increased temperature lowers surface tension.

Date	Diffusion	Exercise
Materials	15 cm of nylex tubing burner (or hydrogen generator) beaker glass tubing	piece of soft chalk (about 1 cm long) soap (detergent)

Procedure

1. Push the piece of chalk halfway up the plastic tube.
2. Blow through the tube. If air goes through easily mould the tube around the chalk until the tube seems to be sealed.
3. Dip the tube in water in a beaker and blow through it. Bubbles should form very slowly.
4. Add some detergent to the water. Dip the tube in and out of the solution until a film is observed over the tube.

   Now blow through the tube. What happens?

   Why?

5. Smear another film over the tube. Insert a piece of glass tubing about halfway on the other side of the chalk and blow. (See figure 1.)

   Does the bubble move?

   Why?

FIG 1.

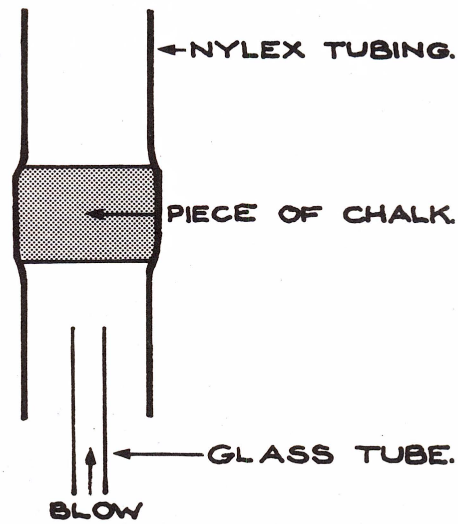
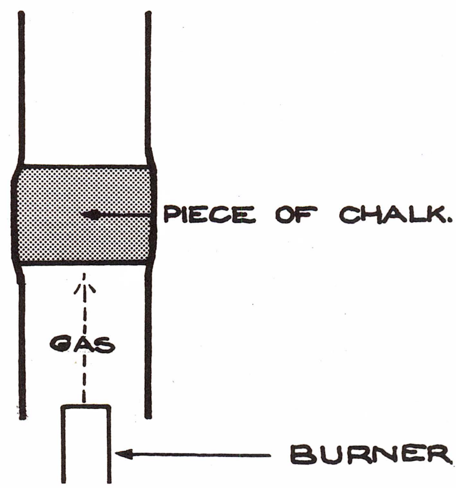


FIG 2.



6. Make sure there is a film over one end of the tube. Place the other end of the tube over the fine jet of a burner (figure 2) and turn on the gas until it very slowly fills the half of the tube.

   (Do not light the gas.) Watch the film carefully. Turn off the gas after about 5 seconds.

   Does the film move?

   Which way?

7. Repeat the process and check your answers (Coal gas contains hydrogen. If a hydrogen generator is supplied use it instead of the gas supply.)
8. Explain why the film moved as it did in step 6.

Date	A Magnet	Exercise

Materials

- 2 magnets
- nylon thread
- plastic bag (small)
- cellulose tape
- iron filings
- copper wire stirrup
- various metals (brass, iron, copper, zinc, steel, etc.)
- various non-metals (plasticine, chalk, wood, glass)
- ferrous (iron) sulphate
- (other iron compounds)

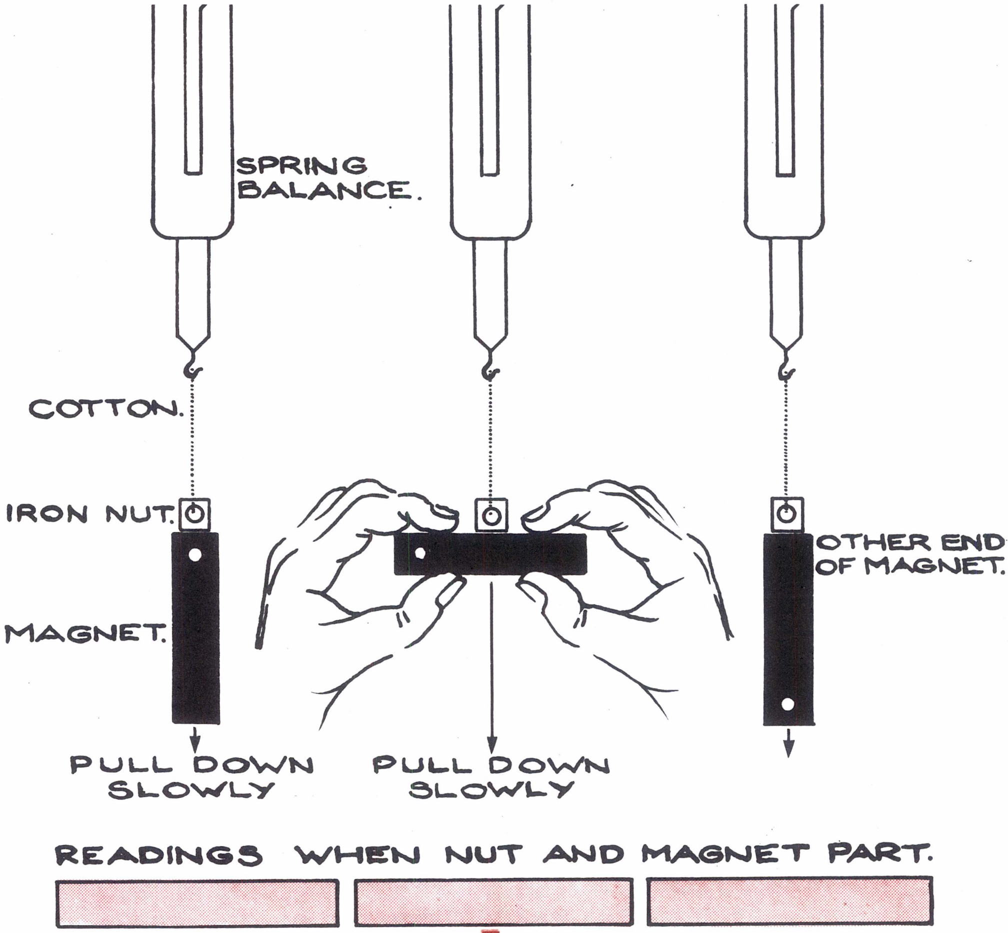
Procedure

1. Wrap the magnet completely in plastic. Complete the wrapping with cellulose tape.
2. Place the magnet in the stirrup and lower it by means of a thread into a pile of iron filings. Gently lift the magnet clear of the filings, observe carefully and sketch what you see.
3. Unwrap the magnet carefully and return the iron filings to their container.
4. Bring the magnet near the pieces of material supplied. Complete the table.

Use the code. A = attracted. Re = repelled. N = no effect.

Substance	*Effect of magnet*
copper	
iron	
brass	
aluminium	
glass	
steel	
plastic	
plasticine	
zinc	
solder	
ferrous sulphate	

5. Study your results.
   Tick any statement below which is supported by your results.
   (a) Magnets attract brass
   (b) Magnets attract metals
   (c) Magnets attract compounds not containing iron
   (d) Magnets attract iron
   (e) Magnets attract compounds containing iron
   (f) Magnets attract steel



6. Hang an iron nut from a spring balance with a length of cotton about 1 foot long.

   What is the reading on the spring balance?

7. Bring the magnet up to touch the iron nut in the manner shown in figure 1. In each case slowly pull the magnet down and record the reading on the spring balance at which the nut leaves the magnet.

   What do your results suggest about the strength of the magnet.

   1.

   2.

8. Hang the magnet in the stirrup from a support which is at least one foot from any substance which is attracted by a magnet. Let the magnet come to rest. Notice the direction in which the magnet is pointing.

   Check this direction with other groups.

9. In step 2, you noticed that most of the magnetic strength of a magnet is concentrated at the end. These positions of strongest magnetic strength are known as the poles. The marked end is the North pole. Why do you think this is called the North pole?

   What is the other pole called?

Date	The Strength of a Magnet		Exercise
Materials	2 bar magnets with N-pole marked keepers and block of non-magnetic material separating. 1 small nail (abt. 2·5 cm)	1 large nail or bolt (preferably without head) 1 piece of glass about 30 cm square	

Procedure

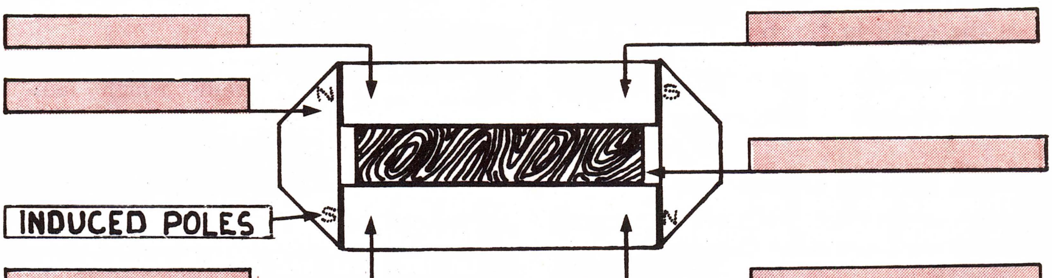
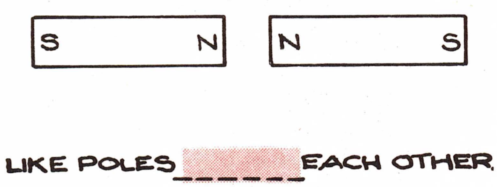


FIG 1

1. Examine the two bar magnets. Complete the labels on figure 1 which shows how the magnets are stored so that they will retain their magnetism.
2. Put the two magnets on the sheet of glass as in figure 2 and slide the two North poles towards each other. Do you feel the North poles attracting or repelling each other?

   The North poles each other.

FIG 2.



3. Now put the two magnets on the glass with the North poles facing each other and about 0·5 cm apart. Let go of both magnets at the same instant. Do the two North poles come together or are they forced apart?

   The North poles

4. Repeat steps 3 and 4 with the two South poles.

   The South poles each other.

   As you bring the magnets closer together, does the force between them become stronger or weaker?

   The closer the poles, the

   is the force between them.

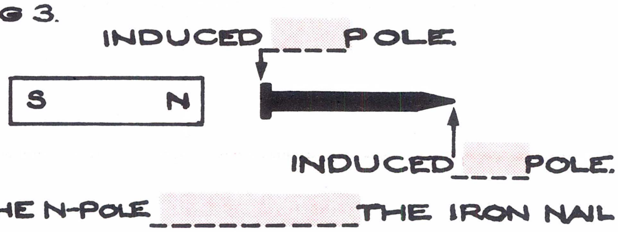
5. Repeat the procedure with a North pole and a South pole. Complete the statements:—

   The unlike poles each other.

   The closer the unlike poles, the

   is the force between them.

FIG 3.



6. Put one magnet on the glass and put a small nail about 2·5 cm from the North pole as in figure 3.

   Does the North pole of the magnet attract or repel the nail?

   The North pole of the magnet
   the nail.

   Is the result in No. 6 the same as for like poles or for unlike poles?

   The same as for poles.

   Therefore the end of the nail nearer the North pole of the magnet has an induced pole.

7. Repeat No. 6 with the South pole of the magnet (figure 4).

   The South pole of the magnet
   the nail.

   Is this result the same as for like poles or for unlike poles?

   The same as for poles.

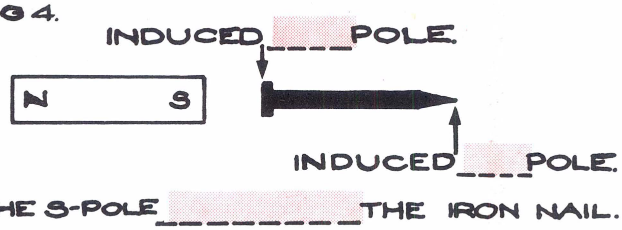
   Therefore the end of the nail nearer the South pole of the magnet has an induced pole.

   Complete the diagrams which summarise these results.

8. To see whether the iron also exerts a force on the magnet, hold the large nail on the glass and slide it towards the magnet. Does the magnet move away from or towards the nail?

   The magnet moves the nail.

FIG 4.

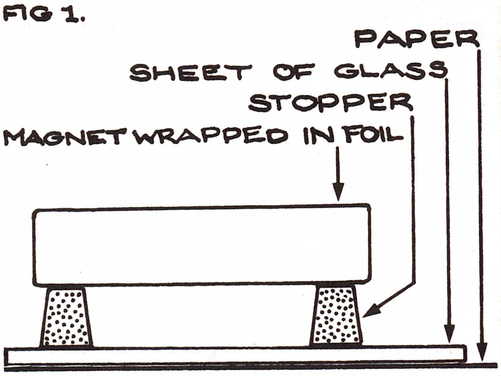


Date	# A Magnetic Field	Exercise
Materials	2 bar magnets plotting compass sheet of glass about 30 cm square 4 small rubber stoppers piece of aluminium foil	plasticine 2 sheets of paper (foolscap or larger) iron filings in shaker

Procedure

1. Neatly wrap the bar magnet in the aluminium foil so that all the edges are square and all of the magnet is covered.
2. Put the sheet of glass over a white sheet of paper on the bench. Place the magnet on two stoppers in the middle of the glass, as in figure 1.

FIG 1.



3. Lightly sprinkle iron filings over, around and under the magnet.
4. Note carefully the iron filings which are sticking to the magnet and also the pattern of iron filings on the sheet of glass. If there is no clear pattern formed by the filings on the glass, tap the glass gently with your middle finger. Observe all changes carefully.

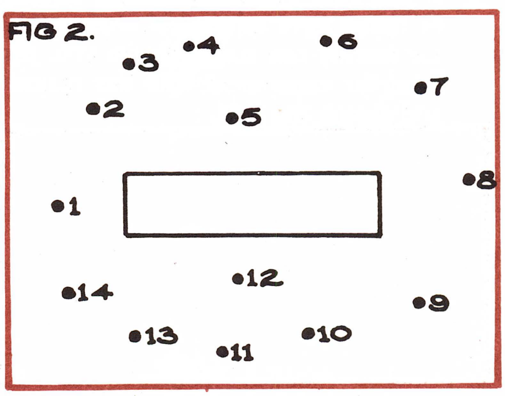
   The greatest number of iron filings was attracted to the ______ of the magnet.

4. Sketch the way in which the iron filings are attracted to the magnet by completing figure 1. If any filings are not lying flat on the glass but are "standing up", show these on the diagram also.
5. Draw the pattern (or the field) of the bar magnet by completing diagram 2, which is a view of the magnet from above.
6. Give direction to the field by placing a compass needle at the points on the glass indicated by the numbers 1, 2, 3, . . . 14 on the diagram.

   At each point put a small arrow indicating the direction in which the North pole of the compass needle points.

   From your diagram, predict which is the North pole of the bar magnet. Mark it in the diagram.

FIG 2.



7. Unwrap the magnet, being careful not to get any iron filings on it. Make sure the iron filings fall on the glass.

   Were you correct in your prediction of which is the North pole?

Mapping Magnetic Fields

1. Put a sheet of white paper on the bench, and place the two magnets on the paper with their poles about 2 inches apart, as in figure 1.
2. Place the four stoppers near the corners of the paper, and carefully place the sheet of glass on the stoppers. Adjust the position of the stoppers so that the glass is well supported on them.
3. Carefully shake iron filings on the glass and observe the pattern which they form. Draw this pattern on figure 1.
4. Place the plotting compass (or compass needle) at several points in the field and note the direction in which the North pole of the compass points. Put arrows on the diagram to show these directions. This shows the direction of the field.
5. Carefully tip the iron filings from the glass onto another piece of paper and transfer them back to the shaker.
6. Set up the magnets as in figure 2, repeat the procedure, draw the field and indicate direction of the field.
7. Set up the magnets as in figure 3, and repeat the procedure.
8. Set up the magnets as in figure 4, and repeat the procedure.
9. If you have a different kind of magnet, or if you have some steel object which the teacher can magnetize for you, perform the experiment with this magnet, and sketch the field.

FIG 1.

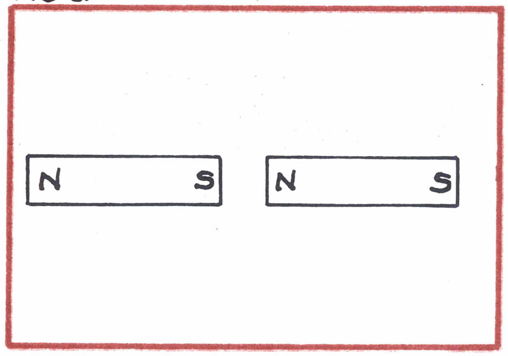


FIG 2.

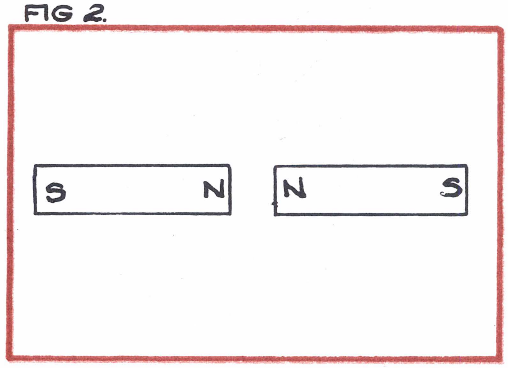


FIG 3.

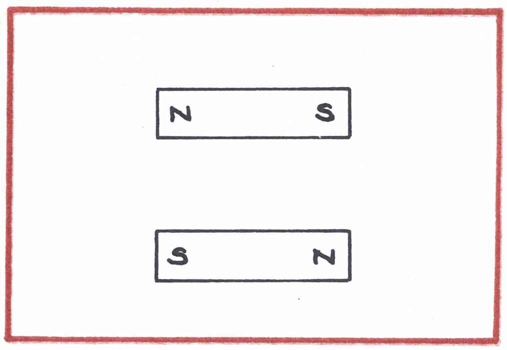
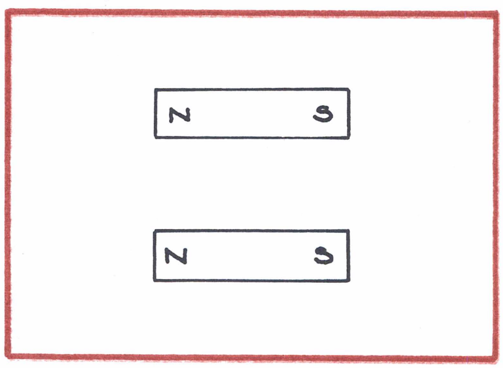


FIG 4.



Date	# Measuring Volume	Exercise

Materials	
	measuring cylinder overflow can filter funnel tea cup pipette, 25 cm^3 small beaker stone on a piece of string rectangular solid on piece of string

Procedure

A. To measure the volume of a liquid

Note: Volumes of liquids may be expressed in ml (millilitres) rather than in cm^3. For all practical purposes the two are considered equivalent.

When using a measuring cylinder always have your eyes at the same level as the level of water in the measuring cylinder, and take the reading to the bottom of the meniscus.

1. Pour a teacup of water into a measuring cylinder and read the volume.

   Record the volume of your cup, and also the volumes of the largest and smallest cups in the class.

   Volume of my cup =

   Volume of largest cup in class =

   Volume of smallest cup in class =

   When cooking, your mother uses a tea cup to measure volume.

   What other measuring devices are used in cooking?

   Why are these not used in the laboratory?

2. Learn to use a pipette to measure out 25 cm^3 of a liquid. Run out four lots of 25 cm^3 water from a pipette into a measuring cylinder.

   Volume you should have in measuring cylinder =

   Volume actually in measuring cylinder =

   Difference =

3. Make a list of factors which could account for the difference (if any) in your readings.

B. To measure the volume of an irregular solid (e.g. a stone)

4. Place the beaker under the spout of the overflow can and pour water into the can until some begins to come out of the spout.
5. When water stops running from the can, remove the beaker and replace it with the measuring cylinder.
6. Slowly lower the stone on the piece of string into the can until the stone is completely under water. When the water has stopped coming out of the spout of the overflow can read the volume of water displaced.

Volume of water displaced =
∴ Volume of the stone =

C. To measure the volume of a regular solid

7. Measure the length, the breadth, and the depth of the rectangular solid in several different places, find the average of each, and calculate its volume.

Length =
Average length =

Breadth =
Average breadth =

Depth =
Average depth =

Volume = length × breadth × depth
= × ×
=

8. Find the volume of the rectangular solid using the overflow can, as in Part B.

Volume of water displaced =
∴ Volume of solid =

Measuring volume is not always easy. Consider the following questions.

1. If you had to measure the volume of a regular solid and you had to do this quickly, which method would you use? (Give a reason.)

2. If you had to measure the volume accurately, which method would you use? (Give a reason.)

3. In one sentence describe how you could find the volume of
a piece of cork,

a lump of sugar,

a sponge.

Date	# A Simple Pendulum	Exercise

Materials	retort stand metre rule stopwatch blackboard protractor	pendulum with bob and split cork piece of plasticine—about 0·15 kg.

Procedure

In this exercise you will investigate the effect of three factors on the period of a pendulum. The factors are

A The length of the pendulum,

B The mass of the bob,

C The amplitude.

Every time, keep the amplitude small—do not let the pendulum swing through more than about 10° from the mean position. If you have time at the end of the experiment, try to find out the effect of making the amplitude much larger.

1. Make the length of the pendulum 50 cm. Time it as it makes one oscillation. Time it again for one oscillation. Do this 3 or 4 times, and obtain an average time for one oscillation.

Time of oscillations	
T_1	s
T_2	s
T_3	s
T_4	s
Total	s
Average T	s

2. Now time the pendulum for 20 oscillations.

Time for 20 oscillations = s

Time for 1 oscillation = s

Why is this a more accurate method of measuring the period of a pendulum than measuring the time for only one swing?

A. The effect of length on the period

3. Make the length of the pendulum 40 cm, time it for 20 oscillations, find the time for 1 oscillation (i.e. the period), record this in the table.
4. Repeat for lengths of 60 cm, 70 cm, 80 cm, 90 cm.
5. Plot these points on graph paper and carefully draw the graph which best fits the points which you have plotted.

Length of pendulum in cm	*Time for 20 osc.*	*Time for 1 osc., i.e. Period*
40		
50		
60		
70		
80		
90		

Put in a sheet of graph paper to face this page

6. From your graph,
   What do you think will be the period of a 100 cm pendulum?

   second

   Check the predictions you have made by measuring the period of the pendulum set to 100 cm.

   What conclusion can you make from the graph?

B. The effect of the mass of the bob on the period

7. Leave the length of the pendulum at 100 cm.

   Mould plasticine evenly around the bob of the pendulum.

   Find the period of the pendulum. Record results.

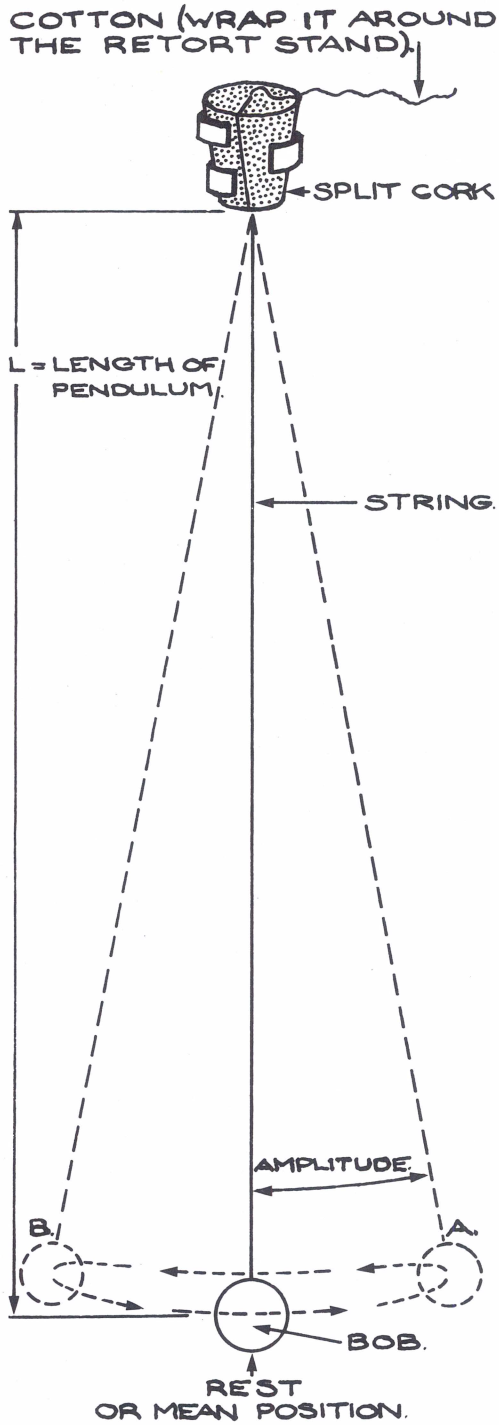
   Repeat as many times as you can, each time with a bob of different mass, but always with the pendulum of the same length (100 cm).

Mass of bob	*Time for 20 osc.*	*Time for 1 osc. i.e. Period*
1	s	s
2	s	s
3	s	s
4	s	s
increasing		

Make a conclusion from these results.

C. The effect of amplitude on the period

Use the blackboard protractor to check the angle through which the pendulum swings, and make the angle fairly large (up to 45°). Write a short discussion of what steps you took, the results which were obtained, and the conclusions which you can make.



1 OSCILLATION = 1 COMPLETE SWING FROM A ► B ► A

PERIOD = TIME FOR ONE OSCILLATION.

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Date	The Extension of a Spring	Exercise
Materials	spring scale pan 50 cm rule	retort stand 2 paper clips set of 10 equal weights

Procedure

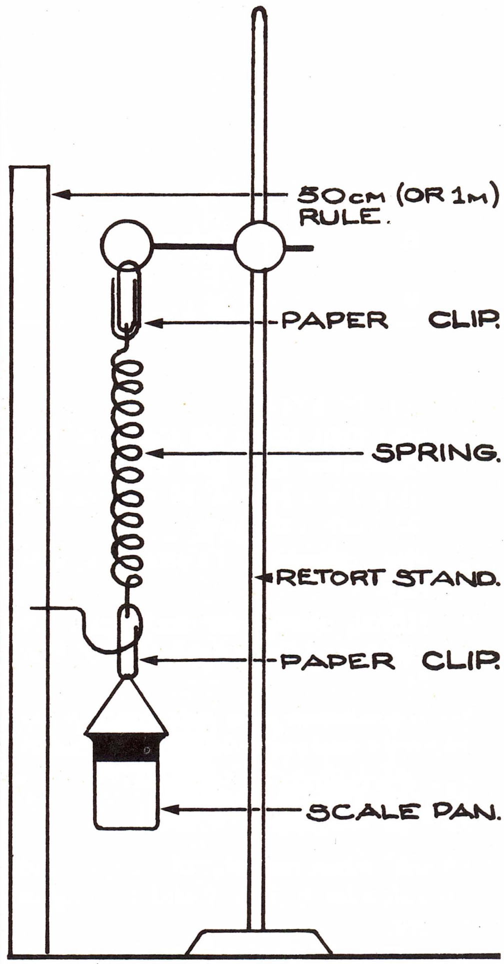
1. Set up the spring, scale and scale pan as shown in the diagram. One paper clip is bent to form the pointer which should be level with the bottom of the spring.
2. Measure the length of the spring and record the result in the table on the next page.
3. Place one weight in the pan, measure the new length and calculate the extension. Record your answers.
4. Take the weight out of the scale pan and check the length of the spring with no load.
5. Repeat 3 and 4 for 2, 3, 4 and 5 weights.
   Each time check the length of the spring with the scale pan empty.
6. Now you have used half the weights supplied and it is important to study your results to see if you can discover some pattern.
   Look at the *table*. About what extension would you expect with a load of 6 weights? cm.

   What extension do you expect with a load of 10 weights? cm.

   What do you think the *length* of the spring will be when it is stretched by

   (a) 6 weights? cm.

   (b) 10 weights? cm.



7. In filling in your answers you have been following a pattern which seems to have been set by the results in the table. Such a pattern can often be seen more clearly by drawing a graph.

Load, (No. of weights)	*Length of spring before weights are added*	*Stretched length of spring*	*Extension*
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

8. Plotting the graph—
   1. First think about the scale you use. Remember that you will need to allow for a load of 10 weights and the likely extension.
   2. Plot extension (Y-axis) against load.
   3. Having chosen the scale, plot the points and draw the graph of best fit.
9. What prediction does your graph make about the extension caused by a load of
   (a) 6 weights? cm.
   (b) 10 weights? cm.
10. Obtain measurements of length and extension for 6, 7, 8, 9 and 10 weights in turn.

    Record your results in the table and plot the points on your graph *as you proceed*.

    Draw the graph of best fit.
11. Did you spoil the spring?
12. How can you tell?
13. Compare extensions produced by

    1 weight cm and 2 weights cm

    2 weights cm and 4 weights cm

    3 weights cm and 6 weights cm

    What deduction can you make about what happens to the extension of the spring when the load is doubled?

    When the load is doubled the extension is
14. Is this conclusion true in all cases?

    Look at the table and the graph before writing an answer.

Put in a sheet of graph paper to face this page

Date	The Weights of Australian Coins	Exercise

Materials

- spring balance (as on page 43)
- beam balance
- ten 1-cent coins
- ten 2-cent coins
- 5-cent coins
- 10-cent coins
- 20-cent coins
- 50-cent coins

Procedure

1. Check the extension of your spring balance with no load.

No load reading centimetres

2. Put ten 1-cent coins in the pan and check the new extension.

Pan only	*Pan and coins*	*Coins only*	X = average extension produced per one-cent coin =

3. Do the same with ten 2-cent coins.

Pan only	*Pan and coins*	*Coins only*	Y = average extension produced per two-cent coin =

4. From 2 and 3, the ratio $\frac{Y}{X} =$

Why do you think the mint makes them like this?

5. What would you expect the average extension produced by a 5-cent coin to be if it was made of the same material?

What is it in fact?

6. Find the average extension produced by a 10-cent coin.

7. Find the average extension produced by a 20-cent coin.

8. Comment on your answers in 5, 6 and 7.

9. On the basis of 5-8, what would you expect the extension produced by a 50-cent coin to be?

What is it in fact?

Comment on your answer.

10. Find the mass of the following coins, using a beam balance and a set of standard masses.

Cent coins	*Mass*
1	
2	
5	
10	
20	
50	

11. Compare the extension produced by each coin with its mass.
The extension is a measure of weight force. Can you find the weight of an object by using a beam balance?

12. Do you think it is possible to find the mass of an object by using a spring balance?

13. The figures below should help you to calibrate your spring balance in newtons:

Coins	*Weight (in newtons)*
10 × 1-cent	0·254 N
10 × 2-cent	0·508 N
10 × 5-cent	0·277 N
10 × 10-cent	0·554 N
10 × 20-cent	1·108 N
10 × 50-cent	1·308 N

Use them to calculate the conversion factor between your weight readings (in centimetres of extension) and proper weight units (newtons). (Start with the largest coin you have weighed, and use the smaller ones to check your value.)

$$\text{conversion factor} = \frac{\text{your reading (in cm)}}{\text{weight in N (from table)}} = \text{cm/N}$$

This will give you the extension, in centimetres, produced by a force of one newton. The rest of the scale can then be filled in.

Date	Density	Exercise

Materials

- 50 cm rule
- 100 cm^3 measuring cylinder
- spring balance
- overflow can
- wooden block
- piece of plasticine
- cotton
- set square
- knife
- solid wooden cylinder

Procedure

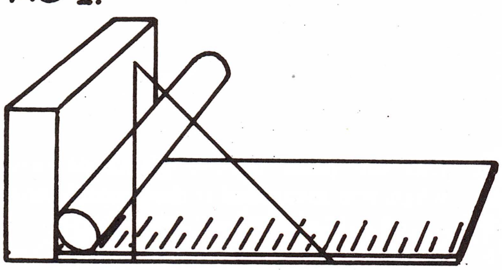
Whenever we want to determine the density of some substance, we must decide how to measure the mass and the volume of a sample of that substance.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}},$$ and is expressed in kilograms per cubic metre (kg/m^3).

A. Density of a regular solid—wooden cylinder

1. Measure the mass of the piece of wood.
2. Measure the length of the piece of wood in four different places and find the average value for the length.
3. Measure the diameter of the piece of wood in four different places (as in diagram, figure 1) and find the average diameter.

FIG 1.



4. Calculate the *volume* of the piece of wood using the formula

$$V = \pi \frac{D^2}{4} l$$

where D = average diameter
l = average length

Mass of piece of wood =

Measurement	*Length*	*Diam.*
First		
Second		
Third		
Fourth		
Total		
Average		

Volume =

5. Calculate the density of the wood. Remember to express your final density in kg/m^3. If you do your initial calculations in grams and cubic centimetres, this conversion will be $1\ g/cm^3 = 1000\ kg/m^3$.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$\therefore$ Density of wood =

B. Density of plasticine

6. Cut a rectangular solid from the piece of plasticine.
7. Measure the mass of the rectangular piece of plasticine. Record your result.
8. Measure the length in four different places. Find the average length.
   Measure the breadth in four different places. Find the average breadth.
   Measure the depth in four different places. Find the average depth.

Mass of rectangular piece of plasticine =

Measurement	*Length*	*Breadth*	*Depth*
First			
Second			
Third			
Fourth			
Total			
Average			

9. Calculate the volume of the piece of plasticine.
10. Calculate the density of plasticine.

Volume =

Density of plasticine =

11. Form the plasticine into an irregular shape.
    Weigh the piece of plasticine.
12. Find the *volume* of the piece of plasticine using the overflow can and measuring cylinder.
13. Calculate the density of plasticine.

Mass of piece of plasticine =

Volume =

Density =

Discussion:

1. Why could you not use the overflow can to measure the volume of the piece of wood?
2. Think of one other simple way in which the volume of the plasticine could have been measured.
3. Did the mass of the plasticine alter when you measured it the second time?
4. Did the density of plasticine change when its shape was changed?

Date	The Density of Liquids	Exercise
Materials	small beaker beam balance pipette (25 cm^3)	250 cm^3 beaker beaker of methylated spirit

Procedure

A. Density of methylated spirit

1. Find the mass of the small beaker.
2. Measure out 100 cm^3 of methylated spirit into the small beaker, using the pipette.

Caution: In using the pipette, be careful not to get any methylated spirit in your mouth.

3. Find the total mass of the beaker and methylated spirit.
   Calculate the mass of the methylated spirit in the beaker.
4. Calculate the density of methylated spirit.

Mass of beaker =
Mass of beaker and methylated spirit =
Mass of methylated spirit =
Volume of methylated spirit =

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} =$$

Density of methylated spirit =

B. Density of water

Repeat the procedure in A, using water, and calculate the density of water.

Mass of beaker and water =
Mass of water =
Volume of water =
Density of water =

Discussion

1. No measurement is exact. Comment on the accuracy of the measurement of volume which you have made.

How accurate is the measurement of mass?

2. You can smell the methylated spirit. This means that methylated spirit is evaporating and you will not have as much at the end of the experiment as you had at the beginning.

How will you have to do the experiment to make this error as small as possible?

3. What special steps would you take if you had to measure the density of ether which evaporates very quickly?

4. You have now found the density of wood, plasticine, methylated spirit and water.

   How many times more dense is plasticine than water?

   This number is known as the *Relative Density* of plasticine.

5. The RD of the wood you tested was

   The RD of methylated spirit is

Eureka

Materials

spring balance
overflow can
2 beakers
two objects A and B, apparently plasticine

Procedure

1. The density of plasticine is
2. Without "opening" the plasticine find out which of the objects has something embedded in it.
3. Describe carefully what you do and give all the information you can about the properties of the embedded object.

Date	The Density of Air	Exercise

Materials

round bottomed flask	beam balance
holed stopper	trough
thick walled plastic or rubber tubing	filter pump
clip	250 cm^3 measuring cyclinder

Procedure

1. Check that the flask is clean and dry.
2. Determine the mass of the stopper, tube, clip and air-filled flask.
   Record your results in the table.
3. Connect the tube to a filter pump and pump the air from the flask for about half a minute. Close the clip, turn off the pump and disconnect the tubing from the pump.
4. Determine the mass of the evacuated flask and fittings. Record your results.
5. Place the flask upside down in the trough filled with water, and slowly loosen the clip under water (figure 1).
6. When no more water enters the flask, move the flask so that the level of water in the flask and the trough is the same (figure 2).
   Clip the tube while the flask is in this position and take the flask out of the trough.
7. Using the measuring cylinder, measure the volume of water which has been forced into the flask.
   Calculate the density of air (at room temperature and pressure).

Mass of flask and fittings + air =

Mass of flask and fittings − air =

∴ Mass of air pumped out =

Volume of water in flask =

∴ Volume of air pumped out =

$$\text{Density of air} = \frac{\text{Mass}}{\text{Volume}}$$

=

8. Find out the temperature and air pressure in the room and state the result fully.

the density of air at °C and cm pressure is

FIG 1.

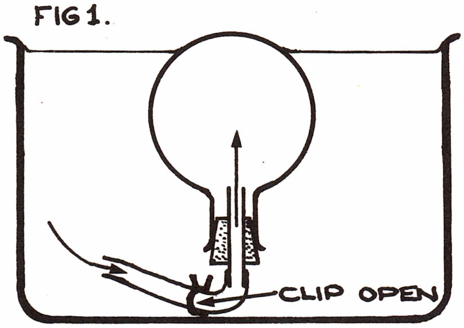
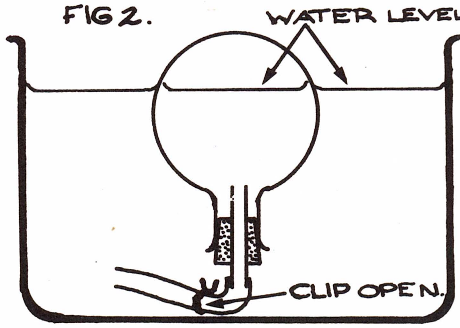


FIG 2.



Discussion

1. Would the density that you have calculated be different if you had pumped out less air?

   Why?

2. Why are temperature and pressure stated when giving the density of a gas?

3. Estimate the volume of air in the laboratory and calculate approximately the mass of air in the laboratory.

Date	The Effect of Mass on Rise in Temperature	Exercise
Materials	3 Joules calorimeters (preferably insulated) 3 thermometers 250 cm³ measuring cylinder bunsen burner tripod gauze mat asbestos mat stirring rod watch beaker 6-volt accumulator (or bench power supply) balance	

Procedure

1. Using a measuring cylinder pour 50 cm^3 of water into the calorimeter.
   What mass of water have you added to the calorimeter?

   What is your reason for giving the answer above?

2. Light the bunsen burner under the tripod.
3. Measure the temperature of the water in the calorimeter and record this in the table.
4. Put the calorimeter on the tripod, stir the water with the stirring rod, not with the thermometer, and take the temperature of the water after 1 minute, 2 minutes, 3 minutes, 4 minutes and 5 minutes. Record the temperatures in the table.
5. Plot the results on graph paper, and label the graph "Mass 0·05 kg".
6. Carefully take the calorimeter off the tripod, pour out the water and cool the calorimeter by pouring in some cold water. Pour out the cold water. *Do not alter the burner flame.*

Mass	*Time (mins.)* 0	1	2	3	4	5
0·05 kg 0·1 kg 0·15 kg *Temp. (°C)*						

7. Repeat the procedure with 0·1 kg and 0·15 kg of water.

Discussion

1. "The same amount of heat was applied to each mass of water in 5 minutes."
   Give a reason to support this statement.

2. The same amount of heat produced an increase in temperature of
   °C in 0·1 kg of water,
   °C in 0·2 kg of water,
   °C in 0.3 kg of water.
3. The results in this experiment indicate that a certain quantity of heat produces a greater rise in temperature in a mass.

Put in a sheet of graph paper to face this page

Another Method

We can use small immersion heaters to supply the same amount of heat to 3 different masses of a liquid and we can observe what temperature rise is produced in each mass of the liquid. In this case we can try kerosene. The apparatus is the same as that on p.55.

1. Measure out 0·15 kg of kerosene into one calorimeter, 0·1 kg into the second calorimeter, and 0·05 kg into the third.
2. Take the temperature of kerosene in each calorimeter.
3. Switch on the current and take the temperature of the kerosene in each calorimeter after each minute for 20 minutes. Record the results in the table and plot them on graph paper.

Discussion

1. The same amount of heat was supplied to each mass of water. In one or two sentences outline an experiment using the apparatus used in this experiment to verify that, in fact, the same amount of heat *is* supplied.

2. From your results calculate the increase in temperature produced by the same amount of heat in each calorimeter in the first 10 minutes.

 °C in 0·15 kg of kerosene,
 °C in 0·1 kg of kerosene,
 °C in 0·05 kg of kerosene.

If the same quantity of heat is supplied to three different masses of the same liquid, the rise in temperature is greatest in the mass of liquid.
The rise in temperature is least in the mass of liquid.

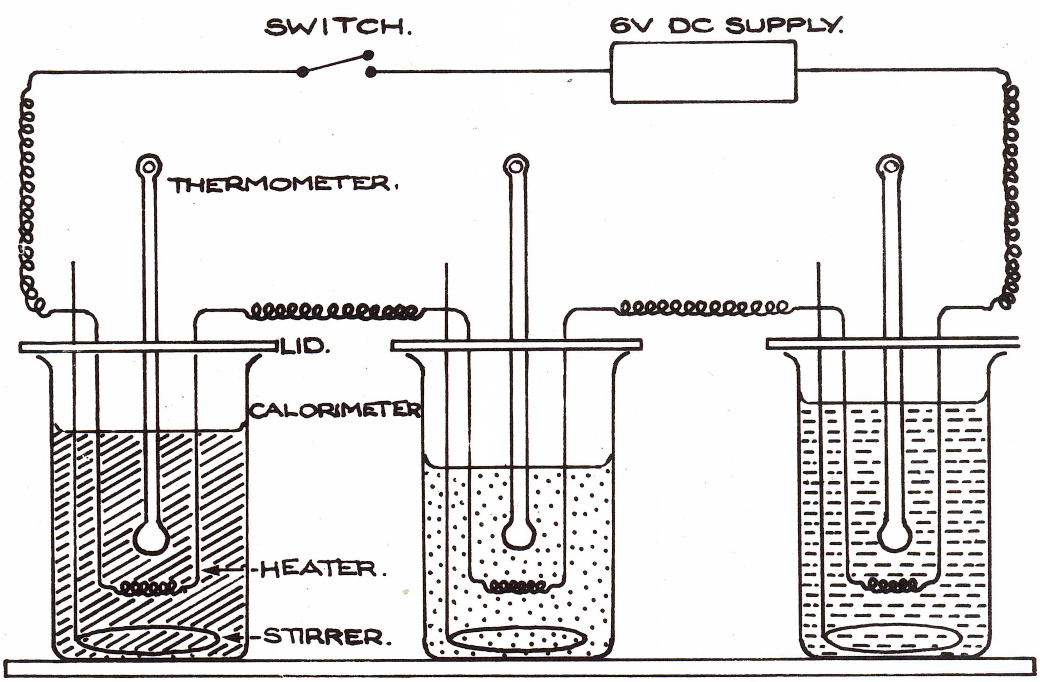
Time (mins.)	*Temperature*		
	0·15 kg	*0·1 kg*	*0·05 kg*
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

3. Suggest possible reasons for the flattening of the graphs at the higher temperatures.

Date	The Effect of the Nature of a Substance on Rise in Temperature	Exercise
Materials	3 Joules calorimeters (preferably insulated) 3 thermometers 6-volt accumulator (or bench supply)	balance beaker methylated spirit water kerosene

Procedure

1. Use the balance to measure out 0·1 kg of methylated spirit into one calorimeter, 0·1 kg of water into a second calorimeter, and 0·1 kg of kerosene into the third calorimeter.
2. Take the temperature of each and record in the table on the next page.
3. Switch on the immersion heaters, take the temperature in each calorimeter after each minute for 20 minutes. Record the results in the table, and plot them on a graph. The liquid in each calorimeter should be stirred gently for about 15 seconds before each reading is taken.



(INSULATION NOT SHOWN)
(EQUAL MASSES OF LIQUID)

Time (mins.)	*Temperature (°C)*		
	methylated spirit	*water*	*kerosene*
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Discussion

1. The same quantity of heat is supplied to each liquid.
   In which liquid does this heat produce the greatest temperature rise?

   In which liquid does this heat produce the smallest temperature rise?

2. Look at the graph.
   How long did you have to heat each liquid to obtain a rise in temperature of 10°C?

	Water	*Methylated spirit*	*Kerosene*
time			

3. Which of the three liquids needs the greatest amount of heat to raise the temperature of 0·1 kg by 10°C?

   Which needs the greatest amount of heat to increase the temperature of 0·1 kg by 1°C?

4. If the specific heat capacity of a substance is the amount of heat required to change the temperature of 1 kg by 1°C, which liquid has the highest specific heat capacity?

   Which liquid has the lowest specific heat capacity?

Put in a sheet of graph paper to face this page

Date	The Cooling Curve of Naphthalene	Exercise
Materials	2·5 cm test tube nearly full of naphthalene flakes 2·5 cm test tube about half full of water retort stand with 2 clamps	tripod with gauze mat bunsen burner 600 cm^3 beaker 2° 0-100°C thermometers

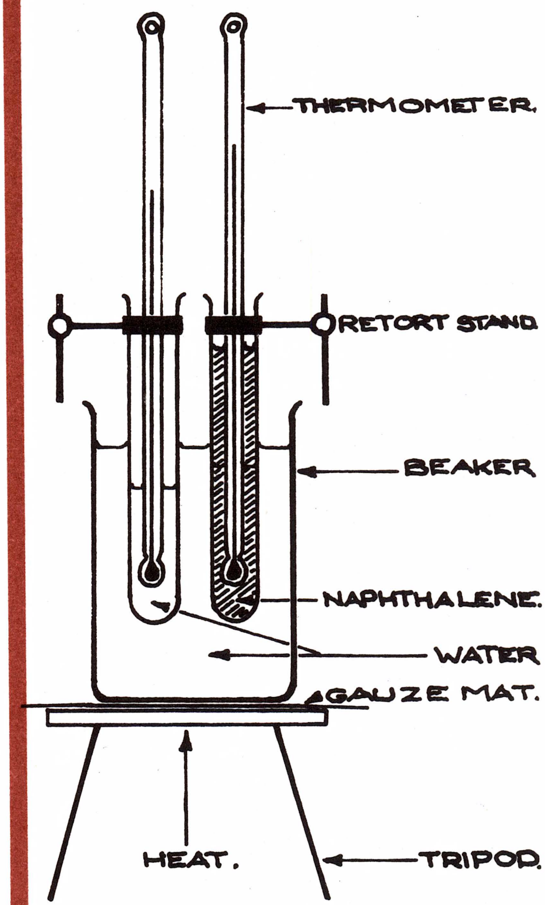
Procedure

You will heat about the same mass of water and of naphthalene to the same temperature, and then you will allow the two substances to cool under the same conditions and record on a graph how they cool.

It is important to plot the points on the graph while you are doing the experiment.

1. Set up the test tube of water and of naphthalene, each with its thermometer as shown in the diagram, and heat the water in the beaker until it has boiled for about a minute.
2. Turn off the bunsen burner and carefully raise each test tube clear of the water in the beaker.
3. *Do not touch the test tubes or the thermometers again.*
   Note the reading on both thermometers, record results in the table for time 0 minutes, and plot these temperatures on the graph page.
4. Every minute for the next 20 minutes, read the temperatures, record them in the table, and plot them on the graph.

   In the table, put a small cross next to the time when you see crystals first forming in the naphthalene, and another cross when you think all the naphthalene has solidified.
5. Carefully draw the two graphs.



Discussion

1. What was the *lowest* temperature reached by the molten (liquid) naphthalene?

2. At what temperature did you first see crystals forming?

3. What is the freezing point of naphthalene?

4. What is the melting point of naphthalene?

5. After you stopped heating the naphthalene, did it lose heat or gain heat?

6. When the temperature of the naphthalene remained constant, was the naphthalene gaining or losing heat?

7. At what stage of the process was heat being lost or gained most quickly? Explain the reasons for your answer.

8. The temperature of the water drops continuously during the experiment, but that of the naphthalene does not—there is a period of time during which the temperature of naphthalene remains constant. The following reasons for this have been suggested by students. Put a cross in the space by the reasons which you think are wrong and write a sentence justifying your decision.

Time (*mins.*)	*Temperature*	
	water	*naphthalene*
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

- The steady temperature of naphthalene is room temperature.
- Naphthalene is always at a temperature greater than room temperature.
- As naphthalene loses heat to the surroundings, some unknown mechanism supplies heat to it at just the right rate to keep its temperature constant.
- Someone heated the naphthalene for a few minutes while you were not looking.
- For a short time naphthalene stops losing heat.

Put in a sheet of graph paper to face this page

Date	Some Properties of Sodium Chloride and Naphthalene	Exercise

Materials		
	burner test tubes test tube holder conductivity set	naphthalene sodium chloride (or potassium nitrate) carbon disulphide

Some Properties of Sodium Chloride and Naphthalene

Procedure

We shall examine some of the properties of sodium chloride (ionic) and naphthalene (solid molecular covalent).

A. Appearance
B. Solubility
C. Conductivity.

A. Appearance

1. Examine the solids and note the colour, feel and odour.

Solid	*Colour*	*Feel*	*Odour*
sodium chloride			
naphthalene			

2. Heat a few grains of naphthalene in a test tube.
Is the melting point high or low?

3. Heat a few grains of sodium chloride in a test tube.
Is the melting point high or low?

B. Solubility

4. Place a few grains of sodium chloride in a test tube and add 5 drops of water and shake.
Record your results by writing soluble or insoluble in the table.

Solid	*Water*	*Carbon disulphide*
sodium chloride		
naphthalene		

5. Repeat with both solids using carbon disulphide instead of water.
Caution: Carbon disulphide is poisonous and highly inflammable. Turn all burners off.

C. Conductivity of molten compound

6. Connect the conductivity apparatus to 6V D.C. and check the globe by touching the electrodes together.
7. Place 3 spots of naphthalene in a test tube and heat it until it melts.
8. Lower the electrodes into the molten naphthalene and note whether or not the globe lights up.

Molten naphthalene is therefore a good / poor / non-conductor of electricity.

9. Disconnect one lead from the set, allow the electrodes to cool and scrape off the naphthalene.
10. Repeat procedures 7 and 8 using sodium chloride instead of naphthalene.

    If you find that the melting point of sodium chloride is too high for your burner to melt it, use potassium nitrate instead.
11. The molten sodium chloride is therefore a   conductor of electricity.

Date	Building Models of Covalent Compounds	Exercise
Materials	student set—ball and spring models	

Procedure

1. Use the colour code to identify the models for various atoms.
2. Examine a spring and twist it gently and carefully in both directions. Notice how twisting against the "thread" tends to expand the spring. Always twist "with the thread", i.e. turn it clockwise, when inserting or removing the spring.
3. Notice that the "atoms" have different numbers of holes and that these are spaced in definite ways. Each hole enables one covalent bond (represented by a spring) to be attached, and the angles between the springs represent the angles between the covalent bonds. This means that the model obtained is a representation of the arrangement of the atoms in three dimensions.
4. Construct models of the following molecules which have single covalent bonds (i.e. bonds in which one pair of electrons is shared) and draw the models in the space provided.

   hydrogen chloride H-C1

   water H_2O

   methane CH_4

   ammonia NH_3

5. Now try for yourself a model of a carbon dioxide molecule and draw it in the space provided.

   CO_2

   Can you see from the model why this molecule is a *linear* molecule, i.e. the three atoms are in a straight line.

6. Construct a model of a molecule of acetylene C_2H_2 and draw a diagram of the model.

What is its shape?

How would you describe this bond between the two carbon atoms?

Now construct models of the following examples of continuous network covalent bonding.

Diamond

7. Bond all of your carbon atoms so that at least the inner atoms are joined to four other atoms.
   Suggest a reason why diamond has a much higher melting point than the other compounds whose models you have constructed.

Silica SiO_2

8. This time use the black "carbon atoms" to represent silicon atoms.
   Attach four springs to a silicon atom and then attach an oxygen atom to each of the springs.
   Attach silicon atoms to the oxygen atoms and continue until you run out of spheres.
   Sketch the model you have made.

In a sample of silica this process continues for millions and millions of atoms. There is no simple molecule such as you found with carbon dioxide. Because of this, the properties of carbon dioxide and silicon dioxide are very different even though carbon and silicon are similar elements.

9. Make other models and draw them.

Date	Bonding and Properties	Exercise

Bonding and Properties

Materials

test tubes
spatula
holder
sugar
sulphur
potassium chloride
ethanol
naphthalene
sodium carbonate
silica
glycerol
methylene chloride
sodium

Procedure

1. Examine samples of the materials listed in the table and note the appearance and state of each. Record your results as you proceed.
2. Place in turn a small sample of each of the solids in a test tube and heat each.
   Note whether the melting point is high or low (the liquids may be classified as having a low MP), and record.
3. Place in turn a small sample of each of the materials in a test tube and to each add 5 drops of water and shake.
   Note whether the substance is soluble or insoluble.

Substance	*Bonding*	*Appearance*	*State*	*High or low MP*	*Sol. in water*
water	covalent				
sugar	covalent				
sulphur	covalent				
potassium chloride	ionic				
ethanol	covalent				
naphthalene	covalent				
sodium carbonate	ionic				
silica	covalent				
glycerol	covalent				
methylene chloride	covalent				

Generalisations

From your results answer yes or no to the following.

Covalent compounds may be liquids or solids.

Ionic compounds may be solid only.

Covalent compounds have low melting point.

Ionic compounds have high melting point.

Covalent compounds are not soluble in water.

Ionic compounds are soluble in water.

This exercise illustrates how difficult it is to make classifications of this kind, particularly when only a small number of substances is examined.

In general, it is possible to say that in *most cases* ionic compounds

(i) are soluble in water,
(ii) are solid,
(iii) have a high melting point;

covalent compounds

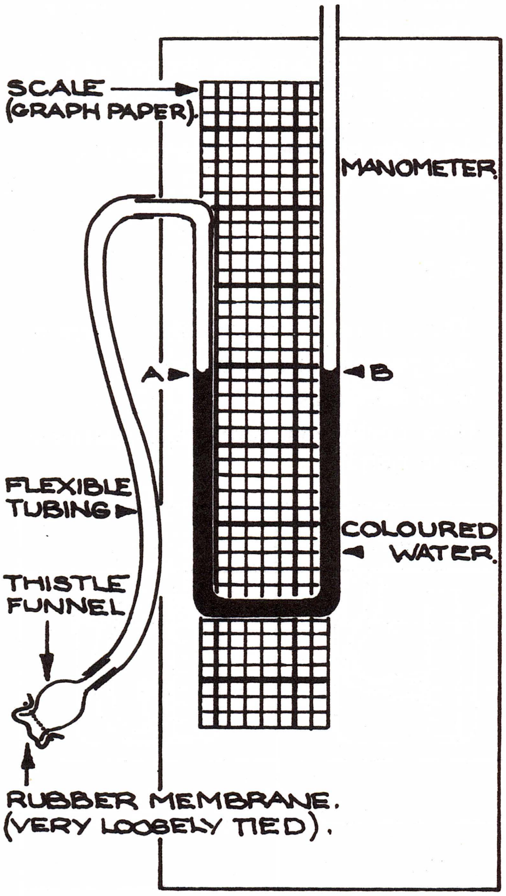
(i) are not soluble in water,
(ii) are gases, liquids or solids,
(iii) have a low melting point if molecular covalent, but a high melting point if continuous lattice covalent.

Date	Pressure in Liquids	Exercise
Materials	manometer with coloured water and scale (ruler) thistle funnel with short stem with rubber membrane 1000 cm^3 beaker with scale attached	

Procedure

The apparatus in figure 1 can be used to detect pressure applied to the membrane over the thistle funnel.

FIG 1



1. Apply a small pressure on the membrane by pushing on it very lightly with a finger.

   What happens to the levels of water in the manometer?

   When a pressure acts on the membrane, the level of water in tube A and the level in tube B

2. Exert a greater pressure on the membrane (care). What happens to the *difference* between the levels in tube A and tube B?

   As the pressure on the membrane is increased, the difference between the levels of water in tube A and tube B

3. Push the thistle funnel into the water in a large beaker in such a way as to make the membrane 1 inch below the water level.

   In the table, fill in the values of water level in tube A, tube B, and the difference between the two levels.

4. Repeat 3 with the membrance 5 cm, 7·5 cm, 10 cm below the surface and record the results in the table.

5. Repeat steps 3 and 4, using methylated spirit instead of water.

   In each case, what does the difference between the two levels measure?

FIG 2.

		1.	2.	3.	4.
		2.5 CM BELOW SURFACE	5 CM BELOW SURFACE	7.5 CM BELOW SURFACE	10 CM BELOW SURFACE
WATER	A				
	B				
	DIFFERENCE				
METHYLATED SPIRITS	A				
	B				
	DIFFERENCE				

6. Look along line 1 of the table. From this what can you deduce about pressure and depth.

   The pressure at a point in a liquid as depth increases.

   Look along line 2 of the table. Do these results support or contradict the statement in No. 2?

   The results for methylated spirit show that pressure with depth.

7. Look down column 4.

   At the same depth, the denser liquid exerts the greater pressure.

   Look down the other columns. Is the previous statement supported or contradicted by the results at the other depths?

   At a given depth a denser liquid exerts a pressure.

8. Using the beaker of water, place the thistle funnel in turn in the positions shown in figure 3 and record the results. In what direction does the pressure act in each case? (Sideways, or downwards, or upwards?)

   In 1, the pressure on the membrane is acting

   In 2

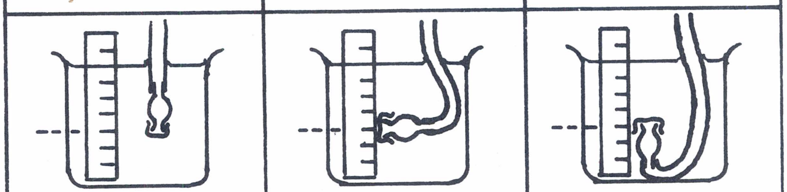
   In 3

   These results support the statement that pressure at a point acts in all directions.

   How could you verify this statement more fully?

FIG 3.

1.	2.	3.



		1.	2.	3.
WATER	A			
	B			
	DIFFERENCE			

Date	Pumps	Exercise
Materials	1 beaker teat pipette measuring cylinder	2 smooth round lead shot grease test tube unit

Procedure

This experiment will test your ability to assemble apparatus.
You may have to make some of the pieces.
As you proceed see if you can think of ways to modify the pump and to improve it.

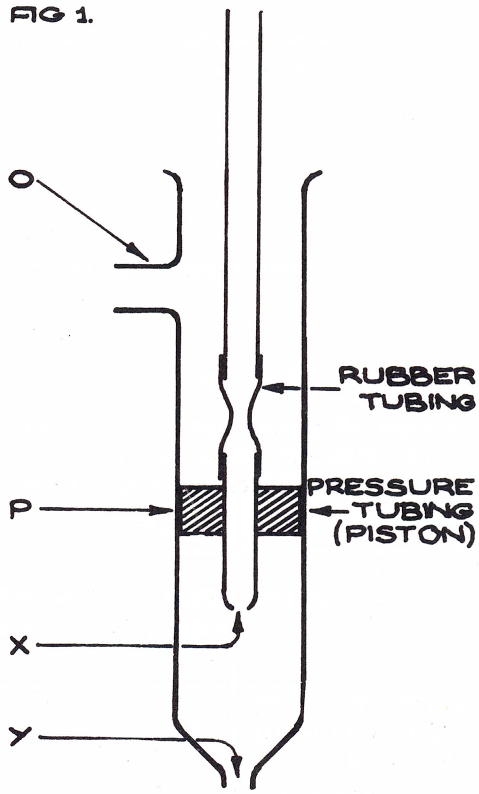
1. Grease the piston P lightly, and practise assembling the parts of the pump as in figure 1. Remove the piston unit from the test tube unit.
2. Lower the empty test tube unit into the beaker.
   Does water enter the barrel?

   Why?

3. Insert the piston to the position shown in figure 2.
   Lift the piston slowly (upstroke).
   Does water rise further in the barrel?

   Why?

FIG 1.



4. Remove the piston, tilt it and allow one lead shot to roll slowly to X.
   Replace the piston as in figure 2 and then lift it slowly as in figure 3.
   Does the water rise?

What can you say about the seal at X?

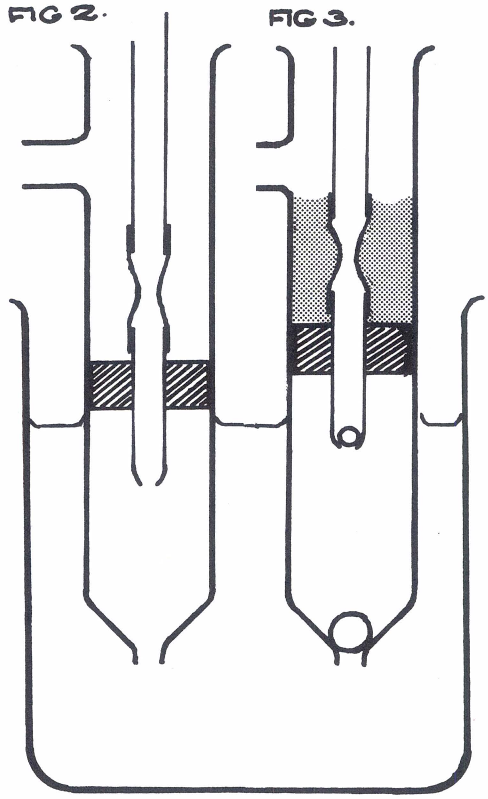
5. Remove the piston assembly, tilt the test tube and roll one lead shot to Y. Replace the piston to the position shown in figure 3 and prime the pump by adding water above the piston with a teat pipette. Add water until it is above the level of the cut in the rubber.
6. Carry out the movements described in Column 1 of the table, observe what happens and complete Columns 2, 3, 4, 5.

   Describe how you would find the delivery rate of your pump.

   Why is this pump called a lift pump?

   Assume all pistons and valves fit perfectly. How far from the surface of water in the beaker can valve X be?

7. Using the apparatus you have been given as the basic unit, design a force pump. Sketch your design.



1 *Movement of piston*	2 *What does the valve at X do?*	3 *What does the valve at Y do?*	4 *Pressure in barrel?*	5 *Does water come out of the spout?*
1st upstroke. Move the piston *up slowly* to the spout.				
1st downstroke. Move the piston *down slowly*.				
2nd upstroke. Move the piston *up slowly*.				
2nd downstroke.				
3rd upstroke.				
3rd downstroke.				

Put in a sheet for your drawing to face this page

Date	An Introduction to Upthrust	Exercise
Materials	spring balance (see p. 70) paper clip	wooden block (approx. $0 \cdot 1$ kg) plasticine (approx. $0 \cdot 1$ kg)

Procedure

1. Hang the plasticine from the spring balance.

   What is the reading on the spring balance? (See note on p. 46.)

   What does this reading measure?

   There are two forces acting on the plasticine. One is the weight of the plasticine (W). The other is the force exerted by the spring (F).
   What can you say about F and W?

2. Now press gently up on the plasticine. What happens to

   (a) the reading on the spring balance?

   (b) the mass of the plasticine?

   (c) the upward force exerted by the spring?

3. Push up a little harder on the plasticine. Push just hard enough to make the spring balance read zero.

   What force are you exerting on the plasticine at this stage?

4. Imagine you have a 5 kg load of wood on a spring balance. Could you make the spring balance read zero by pushing upon the wood?

   With what force would you have to push?

5. What if the load in 4 was a 10 000 kg mass (on a very strong spring balance)? Could you push up hard enough to make the spring read zero?

   If you pushed up with all your strength would you be able to reduce the reading on the spring balance at all?

6. Now lower the plasticine into water until it is fully immersed. Notice what happens to the reading on the spring balance.

   Write down again the original weight of the plasticine.

What is the reading on the spring balance with the plasticine immersed?

What must the water be doing?

7. Remove the plasticine from the water. Hang the piece of wood on the spring balance in place of the plasticine. What is the weight of the wood?

8. Lower the wood into the water. What happens?

What happens to the reading on the spring balance?

What must the water be doing?

Note

The spring balances used in this and the following experiments must be scaled in weight units, that is, newtons.

If all your balances are scaled in mass units (kilograms), paste over a new scale (gravitation force = 9·8 N/kg) or convert all your readings at this rate.

Date	Upthrust	Exercise
Materials	retort stand spring balance (see p. 70) paper clip prepared piece of plasticine A	250 cm^3 beaker with methylated spirit 250 cm^3 beaker with water

Procedure

In this experiment you will investigate some of the facts about the upthrust that a liquid exerts on a body which is placed in that liquid.

The numerical answers that you obtain are not as important as the changes that occur from step to step. Think about these changes and the possible reasons for them, as you perform the experiment.

Refer to the diagrams as you read the instructions.

1. Clamp the spring balance near the top of the retort stand, place the beaker containing methylated spirit directly below it and hang object A from the spring balance (figure 1). Record the weight of object A.

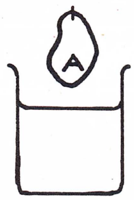


FIG 1

WEIGHT IN AIR.
W =

2. Lower the spring balance until about half the object is submerged in methylated spirit (figure 2).
   Record the reading on the spring balance and also the upthrust (reduction in spring balance reading).

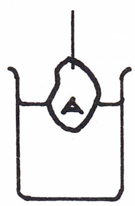


FIG 2.

SPRING BALANCE READING.
S =
∴ UPTHRUST =

3. Lower the spring balance a little further so that about three-quarters of the object is submerged (figure 3).
   Record the spring balance reading and the upthrust.

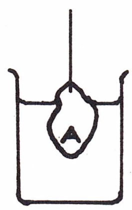


FIG 3

S =
∴ U =

4. Lower the spring balance so that the object is completely submerged (figure 4).
   Record the results as before.

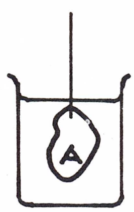
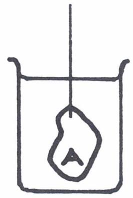


FIG 4

S =
∴ U =

5. Lower the spring balance so that the object is closer to the bottom of the beaker but not touching it.
   Record the results.
6. Repeat steps 1 to 5, using water instead of methylated spirit.
7. Repeat steps 1 to 5 using brine.
8. Summarise your results from 1-7 in the table below.

FIG 5



S =
∴ U =

FROM FIG 1	FIG 2.	FIG 3	FIG 4.	FIG 5
WEIGHT OF A IN AIR = W = . SPRING BALANCE READING = S = . METHYLATED SPIRITS.	W= S=	W= S=	W= S=	W= S=
	UPTHRUST=U=	U=	U=	U=
WATER.	W= S=	W= S=	W= S=	W= S=
	UPTHRUST=U=	U=	U=	U=
BRINE.	W= S=	W= S=	W= S=	W= S=
	UPTHRUST=U=	U=	U=	U=

9. Compare the upthrusts for methylated spirit in columns 2, 3 and 4 of the table of results.
   Now make a statement about what happens to the upthrust on a body as more of that body is immersed.

   Is your statement supported by the results for upthrust obtained with water and brine?

10. Compare the upthrusts in columns 4 and 5 for each liquid.
    If an object is completely immersed in a liquid and then lowered further into the liquid, the upthrust on it

11. The RD of methylated spirit is less than 1 and the RD of brine is greater than 1. Look down column 4. Compare the upthrust exerted on A by each liquid. Complete the following statement:
    If an object sinks in liquids of different RD the upthrust on the object is greatest in the liquid of RD

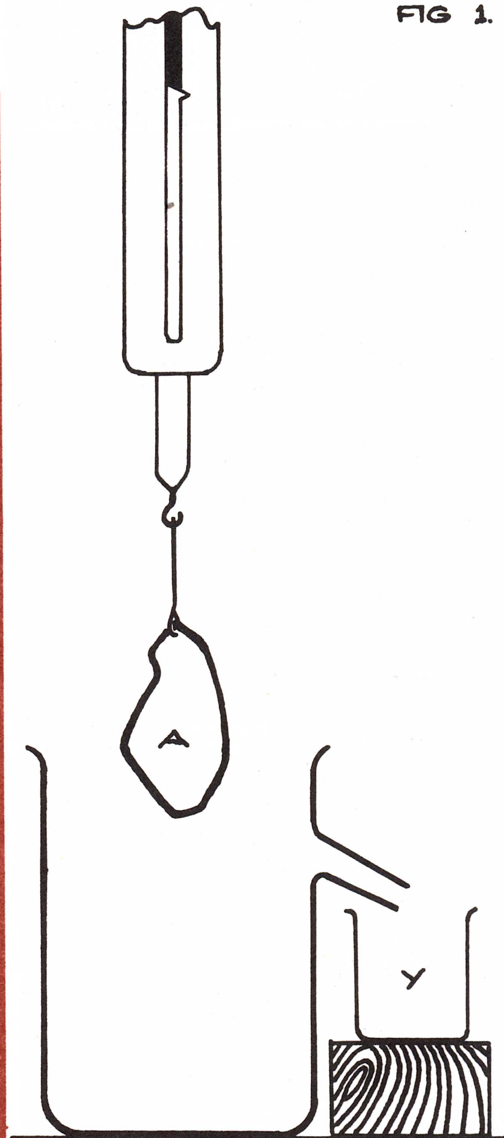
Date	Measuring Upthrust	Exercise

Materials

- spring balance (see p. 70)
- overflow can
- 2 100 cm^3 beakers
- 1 600 cm^3 beaker nearly full of methylated spirit
- 2 lumps of plasticine A and B on filter papers

Procedure

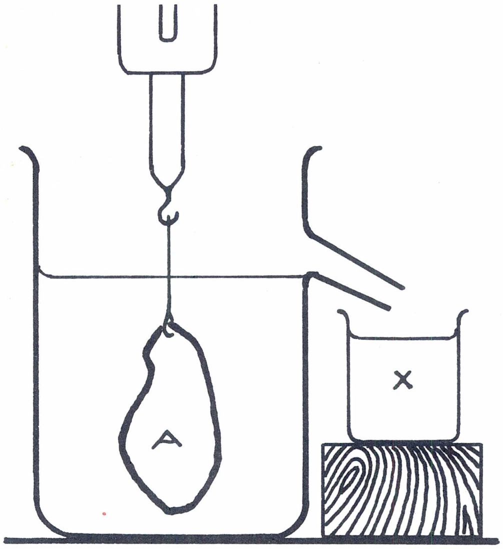
FIG 1.



In an earlier experiment you discovered some facts about upthrust. In this experiment you should discover the principle which determines the magnitude of the upthrust.

Precise measurement is important, and a careless experimental procedure will lead to inconclusive and misleading results.

1. Label the beakers *X* and *Y*.
2. Check the spring balance reading when it has no load.
3. Clamp the spring balance in the retort stand, and suspend beaker *X* from it. Record its weight in the table of results.
4. Arrange the spring balance, the object A, the *empty* overflow can and the beaker *Y* as in figure 1.
5. Record the weight of A.
6. Carefully pour methylated spirit into the overflow can until a little overflows through the spout.
7. Allow the level of methylated spirit to become steady, and when no more is coming out of the spout, empty beaker *Y* into the methylated spirit beaker.
8. Put beaker *X* under the spout of the overflow can, and slowly lower A into the overflow can, allowing the methylated spirit to overflow into the beaker (figure 2). When A is completely submerged, but not touching the sides or bottom of the overflow



can, record the reading on the spring balance. Calculate and record the upthrust exerted by the methylated spirit on A.

9. Remove beaker X from its position below the spout of the overflow can, replace it with beaker Y, raise the spring balance and A back to the position in figure 1, replace A on its filter paper, and weigh beaker X together with the methylated spirit which has been displaced into it.

Calculate the weight of the methylated spirit displaced, and record your results.

10. Fill the overflow can as before with methylated spirit, and repeat the whole procedure with object B.

    Make sure that beaker X is empty before the overflow is collected in it.

11. Pour all the methylated spirit back into its beaker and fill the overflow can with water.

    Repeat all the steps with A and with B, and at each stage record your results in the table.

12. What is the relationship between the upthrust exerted by methylated spirit and the weight of methylated spirit displaced?

13. What is the relationship between the upthrust exerted by water and the weight of water displaced?

14. What generalization can be made about the upthrust exerted on an object immersed in a liquid?

Weight of A in air =

Weight of B in air =

Weight of beaker X =

Situation	1 *Spring balance reading*	2 *Upthrust*	3 *Weight of (2) + liquid displaced*	4 *Weight of liquid displaced*
A in methylated spirit				
B in methylated spirit				
A in water				
B in water				

Date	Upthrust in Gases	Exercise
Materials	1 balloon (round) balance (see p. 70) thermometer metre scale	coal gas (or hydrogen) plasticine cotton

Procedure

1. Measure and record the weight of empty balloon

   weight of the empty balloon =

2. Fill the balloon with gas and tie the rubber in a knot. Tie on a long length of cotton.
3. Measure the diameter of the inflated balloon.

   Diameter =

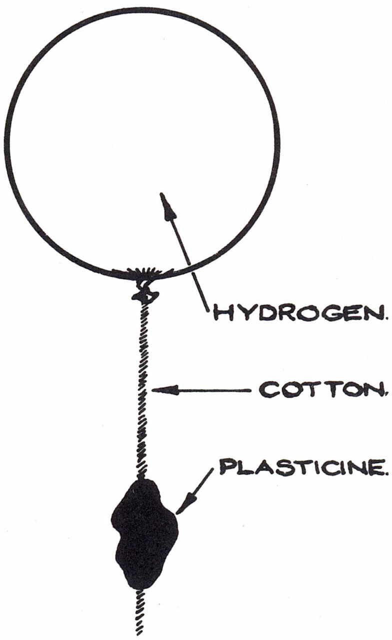
4. Mould a piece of plasticine around the cotton to anchor the balloon.
5. Pinch off pieces of plasticine until the balloon just hangs in the air.
6. Let your partner hold the balloon while you cut off the cotton plus plasticine and weigh them.

   Weight of load =

7. Measure the temperature of the air in the room.

   Room temperature =
   Density of air at this temp. =

8. Calculate the volume of the balloon.



9. Assuming the volume of the balloon = volume of air displaced, calculate the weight of air displaced.

10. Calculate the total downward force.

What part of the downward force will you not know?

11. Comment on the answers to 9 and 10.

Exercise

If you were to remove the load and release the balloon what would happen? Use the following headings in your answer.

(a) in the first few seconds,

(b) as the altitude increased,

(c) after some time assuming the balloon did not burst.

Date	Making a Generalisation	Exercise

Making a Generalisation

Materials

3 teat pipettes
small test tubes
small piece of paraffin wax
piece of plasticine
very small copper pellet
(or lead shot)

small beakers containing
methylated spirit
kerosene
water
glycerine
piece of wood

Procedure

1. From your knowledge of the densities of materials fill in the blank spaces in the table. Check your work with your results of earlier exercises or with a reference book.

Substance	*Density*	RD
water		
methylated spirit		
kerosene		
glycerine		
plasticine		

2. Add 1 cm of water to a test tube using the teat pipette.
3. Add 1 cm of glycerine with another teat pipette. (Keep this pipette for use with glycerine. Try to drop the glycerine into the water without it touching the sides. Allow any glycerine which does touch the sides to run down the tube.)
4. Using a clean teat pipette add, drop by drop down the side of the test tube, 1 cm of methylated spirit.

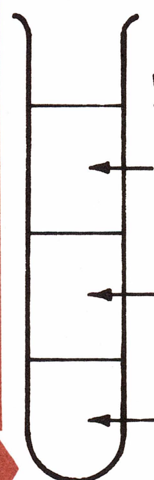
   Note: From now on handle the test tube carefully—do not shake the contents.
5. Complete the labels on the sketch.
6. At this stage we can make this generalization:

   "If any number of liquids are added to a test tube they will form layers in order of their RD."

   Does your evidence so far support this generalization?

7. The evidence in 5 does support the following statement.

   "If a number of liquids which do not mix and do not react chemically are added to a test tube then they will form in layers in order of RD."



LIQUID.	RD

8. Test this generalization by adding 1 cm of kerosense very slowly to the test tube. Check the RD of kerosene from your table.

   Check the position of the kerosene layer.

   Does the statement in 7 hold?

9. Copper has an RD = 8·8.
   Add the copper pellet to the test tube.
   Where does it lodge?

   Can you extend the statement made in 7 to cover the situation?

   Make your statement.

10. What do you think should be done now to check the truth of your statement in 7?

11. You know the RD of plasticine.

    If you add the small piece of plasticine where do you think it will lodge?
    Make your prediction here.

    I predict the plasticine will lodge

12. Drop the piece of plasticine into the test tube.

    Comment on the result.

13. Drop in a piece of paraffin wax.
    Where does it lodge?

    What can you say about the RD of paraffin wax?

14. Drop in a piece of wood.
    Where does it lodge?

    What can you say?

15. If a piece of substance X lodged on top of the methylated spirit layer what could you say about the RD of X?

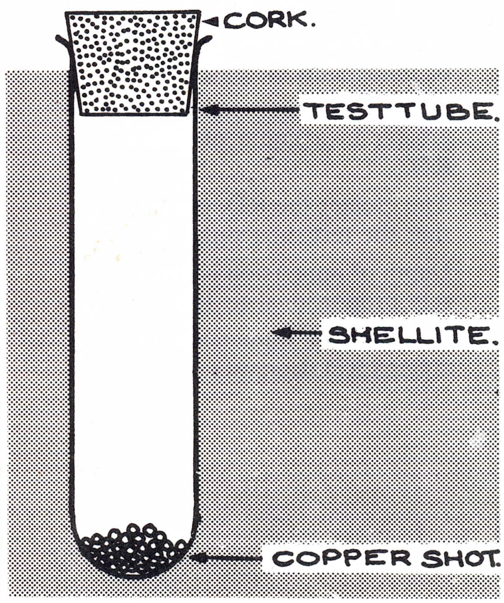
16. In this exercise you have proceeded through certain steps in making a generalization.
    Summarize these steps.

Date	Using a Test Tube Hydrometer	Exercise

Materials		
	1 test tube 2·5 cm cork (to fit test tube) containers cotton graph paper	various liquids, e.g. Shellite, methylated spirit, water, brine, unknown liquid *X* fine copper pellets

Procedure

1. Add fine copper shot to the test tube until the test tube floats upright in Shellite.
   Note: Before placing the loaded test tube in any of the liquids ensure that the cork is in place and that a piece of cotton is tied around the test tube.
2. Continue adding (or removing) shot until the test tube floats in Shellite with only its lip above the liquid level.
3. Remove the test tube from the liquid. Remove the cork, slide a suitably cut piece of graph paper into the test tube and replace the cork. The graph paper enables you to measure depth of immersion of the test tube in various liquids.



1 *Liquid*	2 *Depth of immersion*	3 *Measured* RD	4 $\frac{1}{\textit{Depth of immersion}}$
Shellite			
methylated spirit			
brine			
water			
liquid *X*			

4. (Note that the area of cross-section of the tube is approximately constant throughout its length.) Measure the depth of immersion of the test tube in each of the liquids and complete the table.

5. Look down Columns 2 and 3. What do you notice?

   Which of the following statements are justified by a first inspection of the table? (Use √ and X in first row of squares.)

   The RD is proportional to depth of immersion.

   The RD increases as depth of immersion increases.

   Depth of immersion is greater in a liquid of lower RD.

   The greater the RD, the further the test tube sinks.

   Depth of immersion is inversely proportional to RD.

   As depth of immersion increases RD decreases.

6. Plot the graph of RD against depth of immersion.

7. On the same graph paper but with a different scale on the horizontal axis and different colour, plot RD against $\frac{1}{\text{depth of immersion}}$

8. Use the graph drawn in 8 to find the RD of liquid X.

9. Now that you have drawn the graph go back to step 5 and place a √ in the second row of squares next to all of the statements that are now justified.

10. Make your generalization concerning depth of immersion and relative density. (Remember to include the limitation mentioned in 4.)

Insert graph paper here for your answers

Date	Precipitation Reactions	Exercise

Materials	test tubes solutions of silver nitrate sodium carbonate barium chloride	sodium chloride magnesium sulphate lead nitrate sodium sulphate

Precipitation Reactions

Procedure

1. Place 3 drops of sodium chloride solution in a test tube and add 3 drops of silver nitrate solution.

   What is the colour of the precipitate formed?

   This is a precipitate of silver chloride. What ions have combined to form this compound?

   Write the equation for the reaction.

   What ions have remained in the solution?

   These ions are called "spectator" ions.

2. Repeat the procedure using the following solutions and fill in your results in Table I.

Table I

Solutions		*Precipitate*	*Colour*	*Equation*	*Spectator ions*
magnesium sulphate	sodium carbonate	magnesium carbonate			
lead nitrate	sodium chloride	lead chloride			
barium chloride	sodium sulphate	barium sulphate			

3. Complete the following table.

Table II

		copper carbonate	green		Na^+, SO_4^{--}
lead nitrate		lead sulphate	white		Na^+, NO_3^-

Date	Alkalis (1)	Exercise

Materials

test tubes	sodium hydroxide pellets
watch glass	meat
burner	lead
litmus	iron
phenolphthalein	zinc
methyl orange	magnesium
sodium hydroxide solution	aluminium
ammonium hydroxide	calcium oxide
lime water	other alkalis

Procedure

1. Examine a pellet of sodium hydroxide and then leave it on a watch glass for five minutes. What do you notice?

   Go on with another part while you wait for this.
2. Place a pellet in a test tube and feel the outside of the tube to register the temperature. Add 2 drops of water and feel the test tube again.

   What do you notice about the temperature now?
3. Place 3 drops of the solution you have prepared on a tile.
4. Add 1 drop of litmus to one of these, 1 drop of methyl orange to the second and a drop of phenolphthalein to the third.
5. Record the colours obtained and repeat with the other alkalis available.

Table I

Alkali	*Colour with*		
	litmus	*methyl orange*	*phenolphthalein*
sodium hydroxide			

6. By now, you have probably had some sodium hydroxide solution on your fingers. If not, moisten the tip of your forefinger with sodium hydroxide and rub the finger and thumb together. How would you describe its feel?

Action on skin

7. Examine a piece of meat, e.g. minced meat. Place the meat on a watch glass and add 10 drops of sodium hydroxide solution and warm gently for a few seconds above a small bunsen flame.

   Allow it to cool and examine the meat. What has happened?

8. Place a small sample of aluminium in a test tube and add a few drops of sodium hydroxide solution.
9. Warm it gently and watch for any evidence of a reaction. If a gas is evolved, cover the mouth of the test tube with a finger and test the gas by holding the mouth of the test tube near a flame.
10. Record your results in Table II and repeat procedures 8 and 9 with the other metals listed.

Table II

Metal	*Reaction (yes or no)*	*Gas evolved*
aluminium		
iron		
lead		
zinc		
magnesium		

11. Place one spot of calcium oxide in a test tube, add 2 drops of water and shake it.
12. Add a drop of phenolphthalein.

    What colour change occurs?

This indicates the presence of ions, showing that calcium oxide has reacted with water to form an

There are not many alkalis, for only a few metallic oxides react with water in this way.

List the names of the common ones.

Date	Alkalis (2)	Exercise
Materials	conductivity set glass rod test tubes ammonia solution sodium hydroxide solution litmus hydrochloric acid calcium hydroxide potassium hydroxide	

Procedure

A. To distinguish strong and weak alkalis

1. Place 5 drops of ammonia solution and sodium hydroxide in separate test tubes (these solutions are of equal concentration) and place some water in a third tube.
2. Plug in a conductivity set to 6V DC, switch on and check the globe by putting the electrodes together.
3. Lower the electrodes fully into the ammonia solution and note the brightness of the globe.
4. Wash the electrodes in the test tube of water.
5. Lower the electrodes into the sodium hydroxide solution and again note the brightness of the globe.

What particles must be more abundant in the second solution?

The sodium hydroxide solution is a alkali.

The ammonia solution is a alkali and most of the dissolved ammonia is present in solution as ammonia molecules. Only a small proportion reacts with water so that few are produced.

B. To study the neutralization of acids

6. Place 4 drops of sodium hydroxide solution on a watch glass and add 2 drops of litmus solution.
7. Add dilute hydrochloric acid drop by drop, stirring with a glass rod. Watch carefully and stop adding acid when the litmus becomes its intermediate colour, purple.

   The solution is now not alkaline but neutral. The acid is said to have the sodium hydroxide.
8. Repeat procedures 6 and 7 with potassium, calcium and ammonium hydroxides instead of sodium hydroxide.
9. Repeat with the four alkalis and sulphuric acid.

   In each case the alkaline properties due to the ions are destroyed by the acid. This is the process of
10. Write the equation for the reaction.

Date	Some Properties of Acids	Exercise

Materials

test tubes
burner
watch glass
dilute sulphuric acid
dilute hydrochloric acid
dilute nitric acid
litmus solution
calcium carbonate
copper carbonate
zinc oxide
magnesium
iron
copper
zinc
calcium
lead
sodium carbonate
zinc carbonate
copper oxide

Procedure

A. The effect on indicators

1. You have previously used indicators to test for acids. Complete the table showing the colour produced in acid solution.

Litmus	*Methyl orange*	*Phenolphthalein*

B. Taste

You are familiar with the sour taste of acids in lemons, oranges and vinegar. This sour taste is a characteristic of all acids. However, it is unwise to taste laboratory chemicals and we will therefore assume that sourness of taste is a general characteristic of acids.

C. The neutralization of an alkali

Place 4 drops of dilute sulphuric acid on a watch glass and to this add 2 drops of litmus solution.

What colour is the litmus?

What must be present in the solution of the acid?

3. Add sodium hydroxide solution drop by drop until the litmus becomes purple.

What has happened to the acidic properties of the sulphuric acid?

This same process occurs with other acids and alkalis, as you have shown in the experiment on alkalis.

D. The effect on metals

4. Place 1 cm of magnesium ribbon in a test tube.

Add 3 drops of dilute hydrochloric acid.

What do you expect the gas evolved to be?

How would you test this prediction?

Test it.

Was your prediction correct?

5. Repeat with each of the following metals and indicate with a tick if the result was the same as with magnesium.

Metal	*Gas evolved*	*Metal*	*Gas evolved*
magnesium		zinc	
iron		calcium	
copper		lead	

E. The effect on carbonates

6. Place 2 spots of sodium carbonate in a test tube and to it add 2 drops of dilute hydrochloric acid.
   What happens?

7. Withdraw a sample of the gas using a teat pipette and bubble the gas through 2 drops of lime water in a test tube.
   What happens to the lime water?

   What was the gas evolved?

8. Repeat procedures 6 and 7 with dilute sulphuric and dilute nitric acid. Record your results in the table by marking with a tick if the reaction is the same as with hydrochloric acid.
9. Now repeat the procedures using dilute nitric acid.
   If time permits, other carbonates, e.g. carbonates of calcium, zinc, copper may be used.

Carbonate	*Hydrochloric*	*Sulphuric*	*Nitric*
sodium			
calcium			
zinc			
copper			

What can you conclude about the action of acids on carbonate?

F. The effect on metallic oxides

10. Light a burner.
11. Place a small sample of copper oxide in a test tube and to it add 2 drops of dilute hydrochloric acid.
12. Warm it gently.
    What colour appears?

    What happens to the copper oxide?

    These changes indicate that a chemical reaction is occurring.
13. Repeat with dilute sulphuric acid. Record your results by crossing out the words which do not apply.

    reaction/no reaction.

    Repeat with dilute nitric acid.

    reaction/no reaction.
14. Repeat with all three acids in turn with zinc oxide. This time no colour change will be observed.

dilute hydrochloric	reaction/no reaction
dilute sulphuric	reaction/no reaction
dilute nitric	reaction/no reaction

If sufficient oxide is added, no acidic properties will remain.
Oxides of metals neutralize acids forming water. The salt of the metal remains in solution.

Date	Some Electron Transfer Reactions	Exercise
Materials	tile teat pipette solutions of silver nitrate lead nitrate magnesium sulphate copper sulphate zinc sulphate	strips of:— copper lead magnesium tin platinum zinc

Procedure

1. Place the given strips of metal on a tile in the order shown in the table.
2. Place a drop of each of the solutions listed on each strip of metal in the order shown.
3. Observe carefully if a reaction occurs.
4. Mark each circle with a tick if a reaction occurs. Mark with two diagonal lines or a cross (X) if no reaction occurs.
5. Write the equation for
   (1) The electron loss by the reacting metal.
   (2) The electron gain by the metal ions in solution.
6. Use this table to arrange these metallic elements in a decreasing order of activity.

silver nitrate	lead nitrate	magnesium sulphate	copper sulphate	zinc sulphate	
●	●	●	●	●	Cu
●	●	●	●	●	Pb
●	●	●	●	●	Mg
●	●	●	●	●	Sn
●	●	●	●	●	Pt
●	●	●	●	●	Zn

Date	# The Preparation of Salts	Exercise

Materials

test tubes	dilute hydrochloric
teat pipette	dilute sodium hydroxide
burner	phenolphthalein
holder	copper oxide
crucible (or watch glass)	dilute sulphuric acid
spatula	zinc carbonate
hand lens	magnesium ribbon
filter paper	

Procedure

A. Acid and alkali

1. Place 5 drops of dilute hydrochloric acid in a crucible and add 1 drop of phenolphthalein.

   What is the colour?

   What ions are present in the acid?

2. Add sodium hydroxide solution drop by drop and count the number of drops used before the solution turns a faint pink colour.
3. Discard the solution and wash the crucible.
4. Repeat with 5 drops of dilute hydrochloric acid, no indicator, and add the counted number of drops of sodium hydroxide solution.

   What *two* types of ions present at some stage in the crucible are no longer present?

   Write the equation for the reaction which has occurred.

   What ions remain in the solution as spectator ions?

5. Light the burner and warm the crucible gently above a small flame.
6. Concentrate the solution until nearly dry and allow it to cool.

   What is the substance remaining in the crucible?

7. Remove some of the crystals, examine them with a hand lens and describe their appearance.

B. Acid and basic oxide

1. Light the burner.
2. Place about 2 cm dilute sulphuric acid in a test tube, add 1 spot of copper oxide and warm gently.

   The solution becomes coloured

   This indicates the formation of copper ions in the solution.

   The copper oxide reacts with ions from the acid forming water and ions.

   Equation

   $Cu^{++}O^{--}$ +

3. Filter the solution into a crucible and warm it gently *above* a small flame.

4. Allow to cool when crystals appear. *Do not overheat.*

   Use a spatula to remove some crystals and dry them between absorbent paper. The crystals are hydrated copper sulphate.
   Write the full formula for this.

C. Acid and a carbonate

1. Place about 3 centimetres of dilute sulphuric acid in a test tube.
2. Add 1 spot of zinc carbonate.
   What happens?

   What is the gas formed?

3. Continue adding small samples of zinc carbonate until the reaction ceases. What ions originally present must have been used up?
4. Write the equation for the reaction.

   Filter into a crucible and concentrate the filtrate carefully above a small flame until crystals form.
5. Cool, remove the crystals and dry them between absorbent paper.

D. Acid and a metal

1. Place 3 centimetres of dilute sulphuric acid in a test tube and add 2 cm of magnesium ribbon (rolled up).
   What happens?

   What gas is formed?

   The reaction soon ceases. Why?

2. Add another 2 cm piece of magnesium. The reaction again ceases but some magnesium remains. Why?
3. Decant the solution into a crucible and concentrate it above a small flame until the solution is saturated.
4. Allow to cool, remove and dry the crystals.
   Write the equation for the reaction.

Date	Some Precipitation Reactions	Exercise
Materials	test tubes burner filter paper glass rod filter funnel spatula 25 cm^3 conical flask	wash bottle gauze mat barium chloride solution dilute sulphuric acid silver nitrate solution hydrochloric acid solution sodium chloride solution

Procedure

1. Place about 15 drops of barium chloride in a test tube.

   Add about 15 drops of dilute sulphuric acid and stir the mixture with the glass stirring rod.

2. Filter the mixture through a filter paper and collect the filtrate in a 25 cm^3 conical flask.

   The substance required is the residue which remains on the filter paper. What is the name of the residue?

   What ions from the solutions have precipitated to form this?

   Write the equation for the reaction.

3. Wash the residue with water to remove other ions from it.
4. Unfold the filter paper and heat gently on a gauze mat held in the hot air well above a small bunsen flame.
5. Scrape the dry solid together using your spatula and describe its appearance.

   What ions are present in the filtrate?

   Do your answers assume that the exact required amounts of the two solutions were mixed?

   If the required amounts were not mixed (most likely), what *other* ions might be in the filtrate?

Using Precipitation Reactions

Precipitation reactions can be used as tests for the presence of certain ions in solutions:

A. A test for chloride ions

1. Place 2 drops of sodium chloride solution in a test tube and add 2 drops of silver nitrate solution.

   What is the colour of the precipitate?

   What is the name of the precipitate?

   Write the equation for the reaction.

   The formation of a white precipitate when silver nitrate solution is added is the basis of a standard test for chloride ions in a solution.

2. Test a few drops of
   (1) dilute hydrochloric acid,
   (2) barium chloride solution,
   (3) tap water

   to see if these solutions contain chloride ions.

Solution	*Result*	*Inference*
hydrochloric acid		
barium chloride		
tap water		

B. A test for sulphate ions

3. Place 2 drops of sodium sulphate solution in a test tube and add 2 drops of barium chloride solution.

   What is the colour of the precipitate?

   What is the name of the precipitate?

   Write the equation for the reaction.

   The formation of a white precipitate when barium chloride solution is added is the basis of a standard test for sulphate ions in a solution. Later you will learn how the test is modified to exclude other ions.

4. Use a few drops of dilute sulphuric acid and any other sulphates available to show that these solutions contain sulphate ions.

Solution	*Result with barium chloride*	*Inference*

Date	The Displacement of Hydrogen from Water	Exercise

Materials

For A:	For B:
burner	burner
tile	6 or 12 volt D.C. supply
test tubes	hook up wire
zinc	teat pipette
copper	50 cm^3 beaker
sodium	electrode units (one platinum, one stainless steel)
magnesium	splint
calcium	dilute sulphuric acid

Procedure

A. Displacement by metals

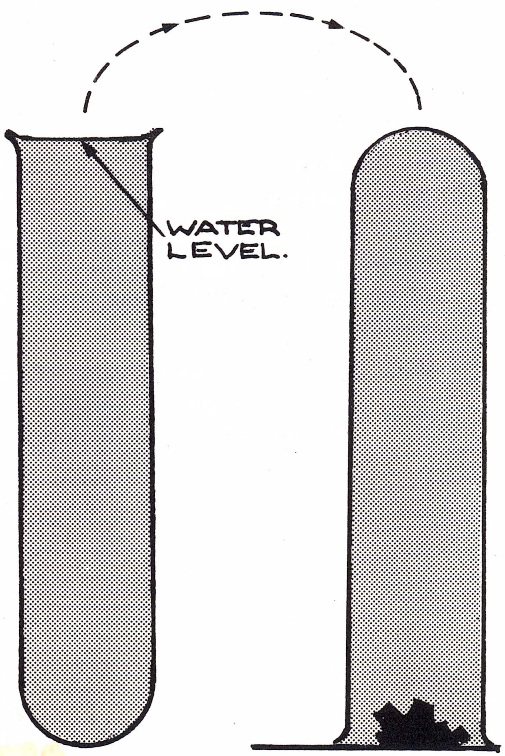
1. Light the burner.
2. Place a small sample of sodium, zinc, copper, magnesium and calcium in separate places on the tile. (The sodium and calcium should be placed well apart.)

Caution: Do not touch sodium with your fingers. Always use a spatula.

3. Fill a test tube to the brim (as shown) with water.
4. Invert the test tube and place it over the piece of sodium.
5. When the reaction has stopped, test the gas by holding the mouth of the test tube near the bunsen flame.
   What happened?

   This shows that the gas evolved was

6. Repeat with a test tube of water for each of the other metals.
   The only other metal which displaced hydrogen from cold water was
   Only very *reactive metals* such as and can displace hydrogen from cold water.



B. Displacement by electrolysis

1. Place about 20 cm^3 of water acidified with 5 drops of dilute sulphuric acid in a 50 cm^3 beaker and, using the pipette, fill the two electrode units with the acidified water.
2. Place the beaker on the stand, put the electrode units in the beaker and support them with the clips.
3. Determine which is the positive connecting wire and connect the electrodes to the D.C. supply. Make the platinum electrode positive (anode).

   What do you observe at each electrode?

At the platinum anode	*At the steel cathode*

What do you notice about the *amount* of gas being collected at each electrode?

Measure the "length" of gas collected at the electrodes.

At the anode cm.

At the cathode cm.

Since the area of cross-section of each electrode unit is the same the "length" of gas collected will be a measure of its volume.

What is the approximate value of the ratio $\dfrac{\text{volume of gas at cathode}}{\text{volume of gas at anode}}$?

4. As soon as one tube is about $\frac{3}{4}$ full of gas, disconnect the leads.
5. Remove the unit containing the greater volume of gas from the clip. Place a finger over the end and invert the unit. Test the gas in the unit for hydrogen.

   What did you do?

   What happened?

   What do you conclude?

6. Remove the other unit in a similar way and test the gas for oxygen.

   What did you do?

   What happened?

   What do you conclude?

The electric current has caused the water to decompose into the two gases and

Twice the volume of was collected at the compared with the volume of collected at the

The formula for water is

If we decomposed hydrogen chloride (HCl) into the two gases from which it is formed the volume ratio would be

Would the same be likely to be true with carbon dioxide (CO_2)? Why?

Date	The Displacement of Hydrogen from Acids by Metals	Exercise

Materials	test tubes burner hydrochloric acid sulphuric acid nitric acid platinum	magnesium calcium zinc iron copper aluminium

Procedure

1. Light the burner.
2. Place a 0·5 cm strip of magnesium in a test tube and add 5 drops of dilute hydrochloric acid.
3. Place a finger over the mouth of the tube for a few seconds, bring it near a flame, remove your finger and then hold the open end of the tube near the burner flame.

   What happened when the acid was added to the magnesium?

   What happened when the tube was held near the burner flame?

   Magnesium displaced hydrogen from the acid. This is recorded by placing a tick in the table as shown.
4. Repeat procedures 2 and 3, using calcium instead of magnesium, and record your results.
5. Repeat these procedures with small samples of zinc, copper, platinum and iron, and record your results by

   √ if hydrogen is formed,

   × if no reaction occurs.
6. Repeat 2 and 3 with each element using dilute sulphuric acid instead of hydrochloric acid.
7. Repeat 2 and 3 with each element using dilute nitric acid instead of hydrochloric acid. If a reaction occurs but hydrogen is not produced, record your results by ⊕.

Metal	*Hydrochloric acid*	*Sulphuric acid*	*Nitric acid*
magnesium			
calcium			
zinc			
copper			
iron			
platinum			

√ = reaction, hydrogen; × = no reaction; ⊕ = reaction, no hydrogen.

Complete these statements:

None of the metals used displaced hydrogen from acid.

Hydrogen was displaced from the two acids and by the reactive metals and

The other metals, and , did not displace hydrogen from acids.

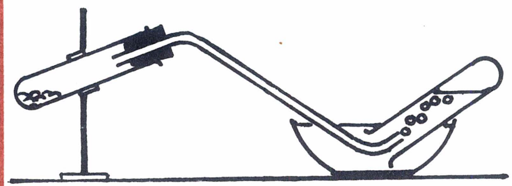
B. A preparation and some properties of Hydrogen.

Materials

test tubes
evaporating dish
corks
delivery tube
sulphuric acid (dilute)
test tube, containing $\frac{1}{3}$ O_2 and $\frac{2}{3}$ water
5 cm piece of magnesium

Procedure

1. Roll up the magnesium, place it in a test tube and to this add about 2 cm of dilute sulphuric acid.
2. Connect the delivery tube arranged for water displacement as shown in diagram.
3. Collect three tubes of hydrogen and fill the oxygen test tube with hydrogen. Comment on
   (1) colour
   (2) odour
4. Shake the corked tube containing a little water, remove the cork under water and observe any level change.
   Hydrogen is therefore   in water.
5. Light the burner.



6. Unstopper a test tube of hydrogen and hold it near the bunsen burner. What happens?
7. Repeat with the mixture of hydrogen and oxygen. What happens?
8. Write the equation for the reaction.

Why were the gases in this mixture measured in the ratio of hydrogen : oxygen = 2 : 1?

Date	Burning Hydrogen Compounds	Exercise
Materials	burner test tubes watch glass holder 4 × 10 cm glass tubing (wide bore)	2 cm twine candle copper sulphate kerosene butter

Procedure

A. Test for water

1. Place 8 spots blue copper sulphate crystals in a test tube.
2. Heat the tube strongly with its mouth pointed downwards and drive out all water.

   Allow it to cool on an asbestos mat and shake out the white anhydrous copper sulphate.
3. Place a few grains of this white powder on a watch glass and add one drop of water.

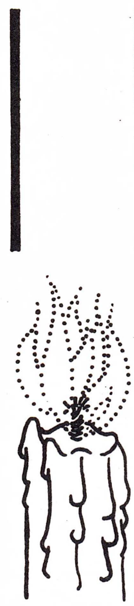
   Observe that the blue colour is restored. This ability of a liquid to cause white anhydrous copper sulphate to become blue is used as a *test for water*.

B. Combustion of compounds of hydrogen

4. Light the wick of a candle and using your holder hold a 10 cm glass tube vertically above the flame. See figure.
5. Examine the inside of the glass tube. What do you *think* you can see?

6. Shake some powdered white amorphous copper sulphate into the tube. What colour change occurs?

   What does this show is present?



7. Repeat procedures 4, 5, 6 with another tube held over a bunsen flame.

   What is the colour change of the copper sulphate this time?

   What conclusions can you make?

8. Cut a 2 cm piece of twine and splay the fibres at one end so that it will sit up on a watch glass.
9. Place a few drops of kerosene on the wick and light the wick.
10. Hold a glass tube in position above the flame and test with anhydrous copper sulphate as before.

    Colour change

    Conclusion.

11. Repeat the above using twine smeared with butter or fat.

    Colour change.

    Conclusion.

The substances burnt were compounds of hydrogen.

In each case one of the products of combustion was

The test for water is that it turns anhydrous copper sulphate

Date	# Weather	Exercise

Materials

For A:	For B:
burner	small burner
raybox	raybox
flask	100 cm^3 beaker
paper (scrap)	tripod and gauze mat
hot water	5 crystals of potassium
ice cubes	permanganate

Procedure

A. Weather in a flask

1. Add a little hot water to the flask.

   Let it stand. Shine the light from the raybox from the side or from under the flask.

   What do you notice *on* the inside of the flask?

   Which of the following statements is true about the relative humidity in the flask? Underline the true ones.

   low, medium, high, 80%, 100%

   Which of the following describes the air temperature in the flask?

   high, very high, dew point, low, room temperature

   Underline any of the following words which correctly describe the droplets on the inside of the flask.

   water, evaporated water, dew, cloud frost, steam, rain

2. Hold a piece of ice in the opening of the flask.

   What happens? (Write full sentences as your answers and set out your observations clearly.)

3. Tip out the contents of the flask. (Save the ice.)
4. Light a piece of paper (about the size of a postage stamp) and drop it in the flask.
5. Replace the ice at the top of the flask.
6. Record what you see. Write your own comment about the effect of smoke particles on cloud formation.

B. A temperature inversion

1. Fill the beaker to about ¾ full with cold water and allow it to stand until still.
2. Shake in the crystals of potassium permanganate.
3. Shine the light from the raybox through the liquid from the side.
4. Heat the water from above as shown (figure 1) and watch for the development of a layer of warm water on the top of the liquid. (Watch carefully.)

   Stop heating when this layer is about 2 cm deep.
5. *Holding the beaker at the bottom* lift it carefully on to a tripod.

   Caution. The top of the beaker will be very hot.
6. Heat the beaker strongly from below.

   Remove the burner the instant movement begins in the beaker.
7. Sketch the pattern of this movement on figure 2.
8. What is the movement of liquid called?

   Does the same kind of thing happen in air?

   What is it called then?

9. Continue heating from below for short intervals. What happens to the streams of coloured liquid as they are forced up and meet the warm layer?

10. Something similar can happen in the air near the ground. As the air near the ground cools a layer of warm air is sometimes found above it. Such a condition is called a temperature inversion.

    What circumstances do you think would be necessary for a temperature inversion to occur?

FIG 1.

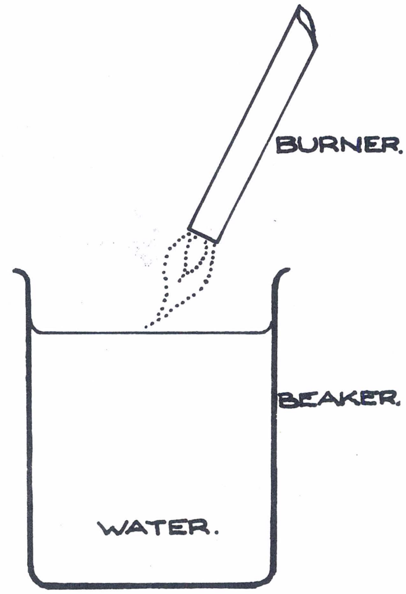
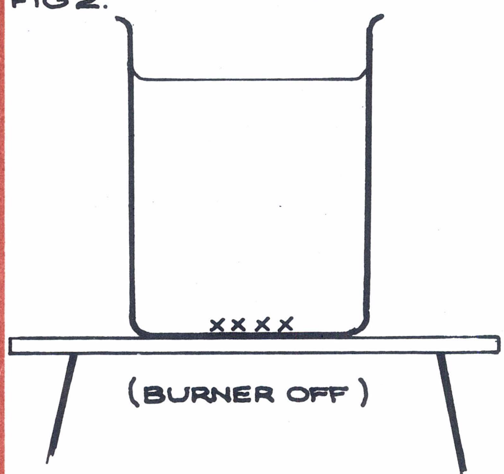


FIG 2.



11. Continue heating until the temperature inversion is broken up.

    When do you think this will occur?

Date	# Measuring Dew Point	Exercise
Materials	shiny can large test tube thermometer	cotton wool ice and salt mixture

Procedure

1. Breathe on the outside of the shiny can. What happens?

   Why?

2. Inspect the outside of the container of ice and salt.

   What do you see?

   Why is it there?

3. Three-quarters fill the test tube with ice-salt mixture.
4. Polish the outside of the can and do not breathe on it again.

   Half fill the can with cold water. Insert the test tube of ice-salt mixture. Stir the water in the can and record the temperature at which the first dew forms on the outside of the can.

   Temperature 1 =

5. Remove the test tube and continue stirring with the thermometer. (Carry out any instructions given about disposing of the ice-salt mixture.)

   Record the temperature at which the dew evaporates.

   Temperature 2 =

   Average of temperatures 1 and 2 =

   What do you call this temperature?

   Suppose your neighbour records an answer which is several degrees higher than yours.

   Suggest a possible reason for this.

   Suppose all doors and windows in the laboratory are kept closed for the lesson. If you repeat your experiment at the end of the lesson what should happen to your answer? Why?

Date	# The Weather Map	Exercise
Materials	weather map (from daily paper) glue	

Procedure

1. Paste today's map and forecast in the space provided. This is the experts' prediction.

   Go outside and observe the weather conditions and record your observations in the table below.

   Look again at the map and at your observations and try to predict what will be happening at this time on Tuesday.

   Enter your prediction in column A on the next page.

paste Monday's weather map and forecast here.

Temperature	
Type of cloud	
Wind direction	
Wind speed	
Precipitation	
Humidity	

2. **On Tuesday**
   Paste today's map in the space provided. Observe the weather conditions at the same time as you did on Monday and record them in column B. Make and write in a prediction for Wednesday.
3. Do the same on Wednesday.
4. Make out a table like the one over the page for Thursday and Friday.
   Are you getting better at "weather forecasting"?

paste Tuesday's
map and forecast
here.

THE WEATHER AT .... AM/PM ON TUESDAY ....../....../......		
	(A) As predicted on Monday.	(B) As it actually was
Temperature		
Type of cloud		
Wind direction		
Wind speed		
Precipitation		
Humidity		

paste Wednesday's
map and forecast
here.

THE WEATHER AT .... AM/PM ON WEDNESDAY ....../....../......		
	(A) As predicted on Tuesday	(B) As it actually was
Temperature		
Type of cloud		
Wind direction		
Wind speed		
Precipitation		
Humidity		

Insert your sheet for other maps

Date	Porosity and Permeability	Exercise
Materials	**For A:** 4 beakers or identical jars or fruit tins measuring cylinder fine (1·0 cm) screened gravel coarse (2·0) screened gravel oven dry sand water cement **For B:** You and two helpers 4 small beakers	3 spring pegs teat pipette watch (second hand) stirring rod glass wool 3 7·5 cm test tubes with a hole in the bottom water very coarse sand fine sand crushed clay

Procedure

A. Porosity

1. Fill one beaker with 1·3 cm gravel.
2. Fill the measuring cylinder to the top mark and then pour water from it into the beaker with gravel. Do this until the beaker is full.

1·3 cm gravel

Original reading in cylinder =

Final reading =

∴ Volume of water received by gravel =

3. Repeat using 0·7 cm gravel and record your results.

0·7 cm gravel

Original reading =

Final reading =

∴ Volume received by gravel =

4. Repeat, using sand, and record your results.

Sand

Original reading =

Final reading =

∴ Volume received by sand =

In the separate parts of the above exercises you used particles of approximately the same size and you used water to determine the volume of the air space. What can you say about the porosity of coarse gravel, fine gravel and sand?

5. Fill another beaker with 1·3 cm gravel.
6. Pour sand into the beaker and notice that the sand occupies the spaces between the pieces of gravel.
7. Now repeat procedures 2 and 3.
8. What can you say about the porosity of sand and gravel mixture compared to that of the gravel?

Sand and gravel

Original reading = cm^3

Final reading = cm^3

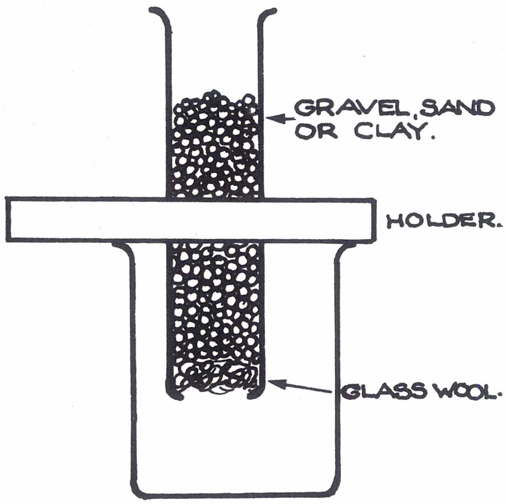
∴ Volume received by the sand and gravel = cm^3

The porosity is when particles of the same size are packed together. When smaller particles fill the holes the porosity is

B. Permeability

1. Each member of the team of 3 can prepare one set of apparatus. Use your stirring rod to place a small piece of glass wool in the bottom of each test tube.
2. Half fill one test tube with gravel, another with sand and the third with clay.
3. Arrange each set as shown.
4. You must now work as a team. One will be the experimenter (E), one the timer (T) and one the counter (C). Read *all* of the instructions in 5 *before* you proceed.
5. E: Draw water into your pipette, and when T gives you the signal release 20 drops into the test tube containing the gravel.
   C: You will count the number of drops which drip from the end of the test tube. Stop counting as soon as the drops stop coming freely. Tell T when you stop counting.
   T: You will give E the signal when to add the water and then take the time until C tells you to stop.
6. Carry out instruction 5 and record your results.
7. Change your duties and repeat 5 for sand and clay. Record your results. Which sample is most permeable?

In the time limits of this experiment clay is



8. Your teacher will arrange for one clay test tube to remain set up in your class room. Examine it from day to day.

After days water had passed through the clay. Therefore, although it seemed at first that clay was the extended experiment shows that it is

Sample	*Time counted*	*Number of drops*	*Permeable or impermeable*
gravel			
sand			
clay			

Date	Ground Water	Exercise

Materials

For A:
large tin (ice cream tin)
smaller tin with bottom and top removed
sand and soil
water
soft foam plastic

For B:
Choose your own.

For C:
thin tracing paper
2 different coloured pencils
cellulose adhesive tape
reference book showing distribution of sheep and cattle in Australia

Procedure

A. A model well.

1. Answer the following questions about the model well shown in figure 1.

   Which layer represents the impermeable layer?

   Which layer represents the aquifer?

   Mark in a water table and label the zone of saturation.

   If the sand were replaced by clay,

   (1) Would water ever rise in the well?

   (2) Would water rise rapidly in the well?

   Explain your answers.

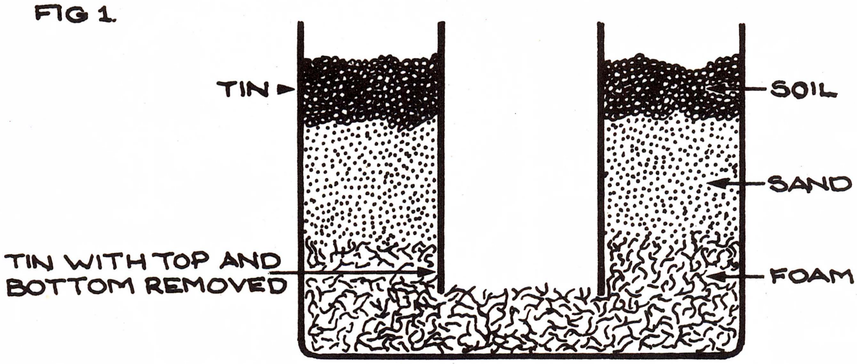
   Which model well, if used, would refill the slower?

   Why did you make this choice?

   Would it be permanently dry?

2. Make the model and confirm (or otherwise) the answers you have given.

FIG 1.



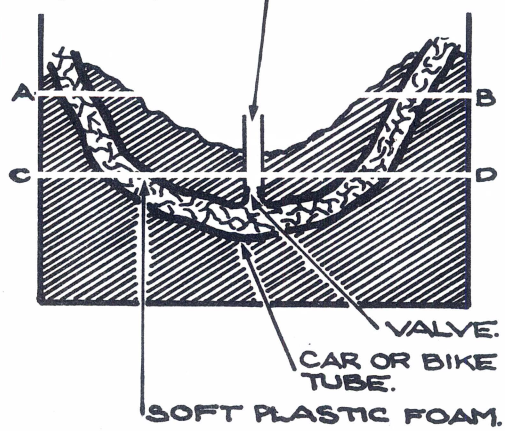
B. An artesian bore

1. Study figure 1.
2. For an artesian bore the aquifer must be enclosed by impervious rock.
   What is the aquifer in the model?
   What is the impervious "rock" in the model?
   If the water table is AB what kind of bore is shown?
   If the water table is CD what kind of bore is shown?
   Write full answers to these questions on your own paper.
3. Select your own materials and make your artesian bore model.

C. Artesian water

1. Trace the outline of the map given here.
2. Mark on this map with a coloured pencil the distribution of cattle in Australia. You will find the information in a geography book in your library.
3. Trace another outline of the map with a different coloured pencil and on this

FIG 2.

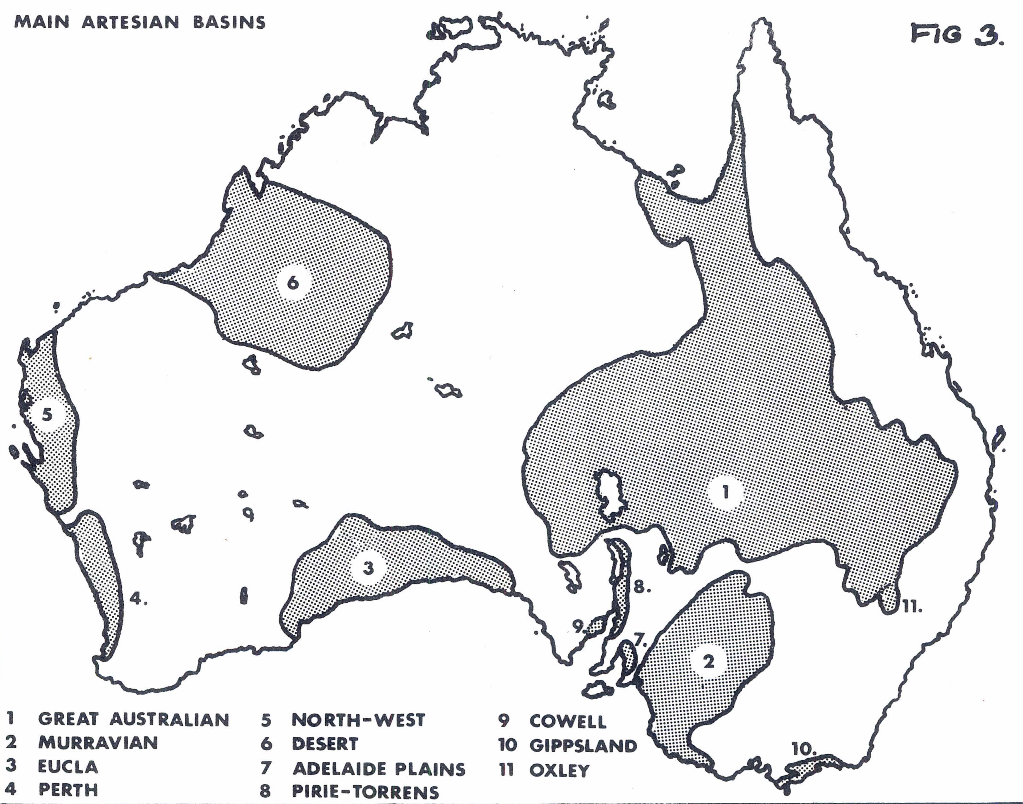


mark the distribution of sheep in Australia.

4. Fasten one edge of each tracing to this page so that they lay over figure exactly.
   What do you notice about the distribution of cattle in relation to the artesian basins?
   What do you notice about the distribution of sheep in relation to the artesian basins?

MAIN ARTESIAN BASINS

FIG 3.



Insert paper here for your answers

Date	Soil	Exercise
Materials	**For Part I:** spade posthole digger small plastic bags string field notebook paper strip 45 cm x 10 cm piece of masonite glue	measuring tape labels **For Part II:** gas jar test tubes samples of sand, loam, clay

Procedure

Part I: A soil profile

A. In the field

1. Examine the side of a cutting or trench. If necessary clean part of the face with the spade.
2. Notice and record the number of horizons you can see.
3. Sketch the profile and add to the sketch the following information.
   (i) Depth of the profile,
   (ii) Depth of each layer,
   (iii) Description of each layer,
   (iv) Position of the situation in relation to hills, rivers, plains, etc.,
   (v) Type of vegetation.
4. Place a sample from each layer into a separate bag, label it and seal it.

B. At home or at school—a model

1. You will now make a 45 cm model of the soil profile you have studied. Work out a suitable scale and rule the piece of hardboard accordingly.
2. Rule a margin 3 cm wide down the length of the board. Leave this clear for labels later.
3. Arrange your samples in order, spread glue onto the board and then sprinkle samples onto the appropriate sections on the board.
4. Allow this to dry and then fix a strip of white paper in the margin you have left. Write essential labels on the strip and you will have a complete model of the profile you have studied.

Part II. The make-up of soil

A. The texture of soil

1. Moisten a small sample of sand and work it between your thumb and finger.

   Describe what you feel.

2. Repeat this with loam.

3. Repeat this with clay.

   The texture of soil refers to the feel when moistened soil is worked between thumb and finger.

4. Place 5 cm to 10 cm of garden soil in a gas jar. Fill it with water, shake it and allow it to stand.

   Describe your findings by means of a labelled diagram in the accompanying space.

   Soil is made up of particles of different

B. The structure of soil

5. Place a sample of dry sand on a piece of white paper and rub it.

   Do the sand grains hold together?

6. Repeat this with garden loam and then with clay.

   The sand crumbled into grains.

   Some of the loam crumbled into grains but some

   With the clay

   Structure refers to the way the particles hold together or *aggregate*.

C. Permeability and water-holding capacity of soil

7. Set up 3 test tubes as in page 108, one containing sand, another loam and the third clay.
8. Repeat instructions 5 and 6 on p. 108.

   is more permeable than either or

   The amount of water which passes through gives a measure of the amount held by the soil.

   Most water was held by the

   Least water was held by

   Therefore the water-holding capacity of clay is than that of sand.

Date	# Dissection of a Mammal	Exercise
Materials	small mammal dissecting board dissecting pins or fine nails scalpel	forceps scissors seeker

Procedure

A. The gastro-intestinal tract

1. Pin out the animal and open the abdomen (instructions on page 17).
2. Identify the organs labelled in figure 1.

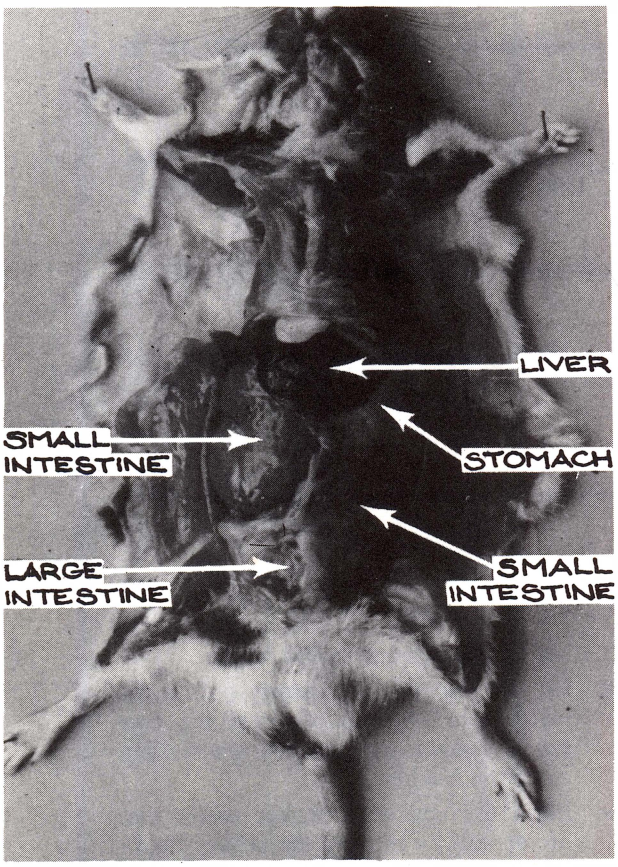


FIG 1. RAT.

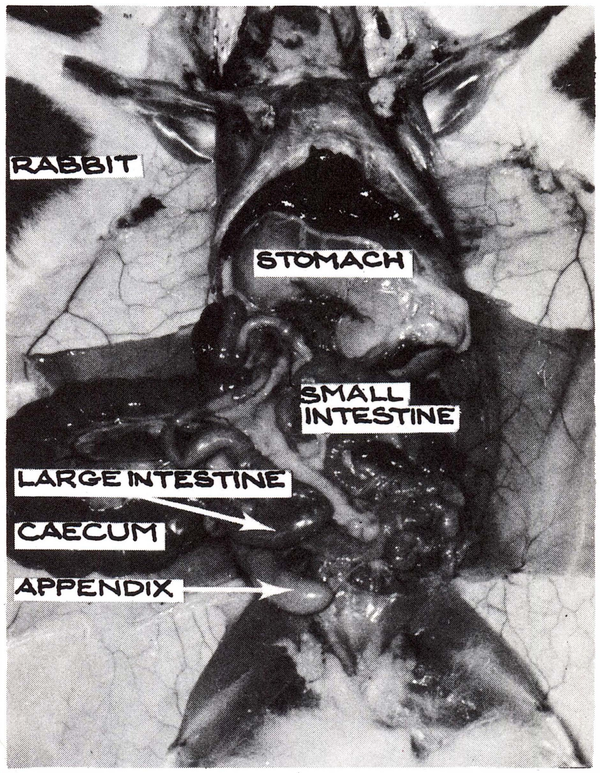


FIG 2.

3. Displace the intestines to your left. Notice that they are held together by membranes.

   The gut can be unravelled by carefully pulling apart those sections joined together by membranes.

   Only unravel sufficient to enable you to follow the parts of the G-I tract.

   Find the *oesophagus* where it comes through the diaphragm to the *stomach, duodenum* with the *pancreas* in its fold, *small intestine, caecum appendix, large intestine, rectum, anus.*

B. Part of the circulatory system

4. Notice the large number of small vessels in a fan in the membranes.
   Notice the large number from the intestines.

5. Notice the large vessels entering and leaving the liver. Trace the small vessels from the intestines as they join to the larger ones to the liver. This is part of the *hepatic-portal system*.
6. Cut the rectum near the anus and displace the intestines even further.
   Notice the important blood vessels on the "floor" of the abdominal cavity.
   (1) large vessels to and from the legs,
   (2) the dorsal aorta and posterior vena cava,
   (3) the renal veins and arteries (kidneys).

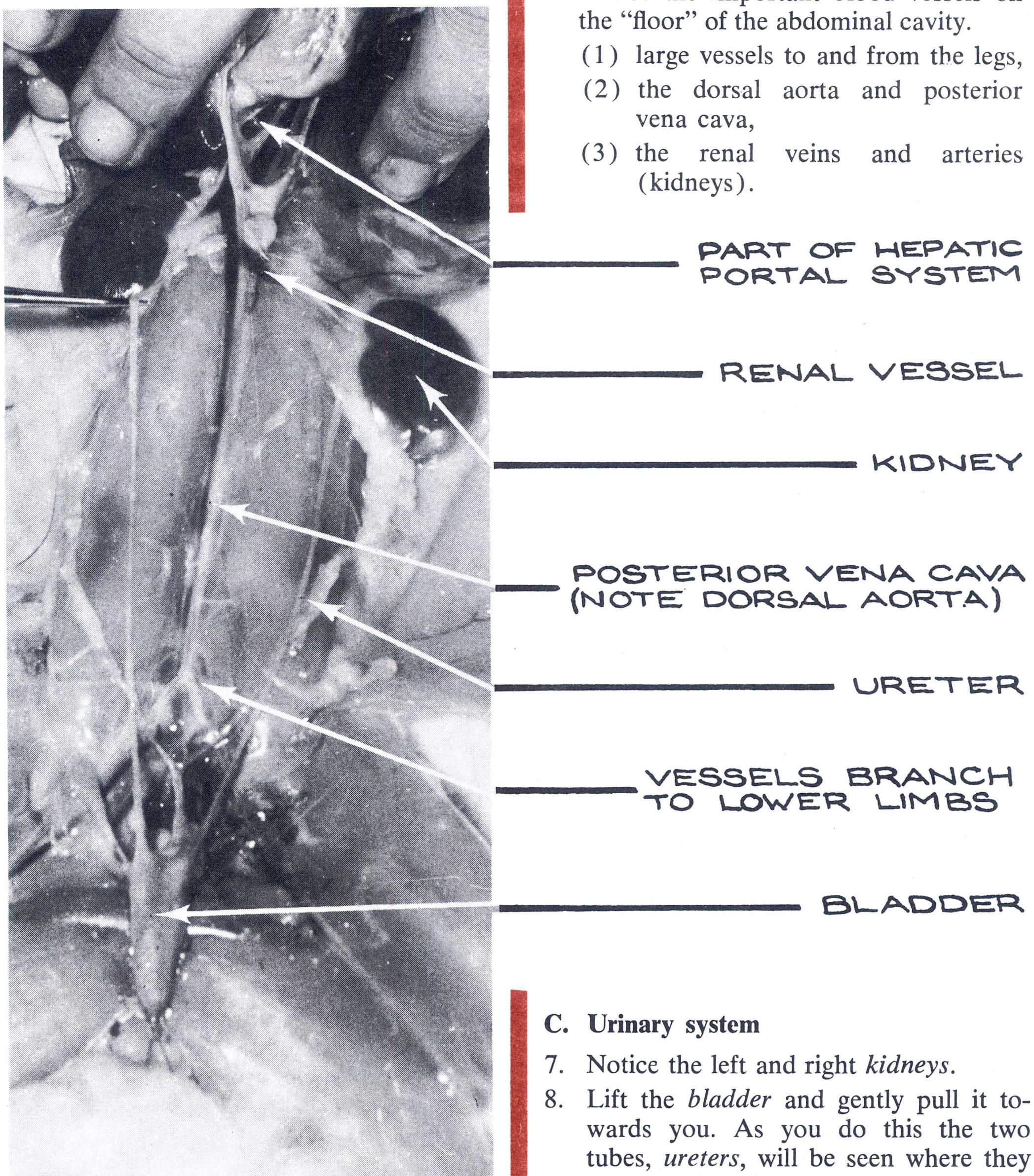


FIG 3.

C. Urinary system

7. Notice the left and right *kidneys*.
8. Lift the *bladder* and gently pull it towards you. As you do this the two tubes, *ureters*, will be seen where they enter the bladder.
9. Place the end of a seeker under one ureter and by moving the seeker backwards and forwards trace the ureter to the kidney.

D. Reproductive system

10. Confirm the sex by checking the photographs on this page.

Female.

11. Use your seeker to find *ovaries, oviducts, uteri* and *vagina.*

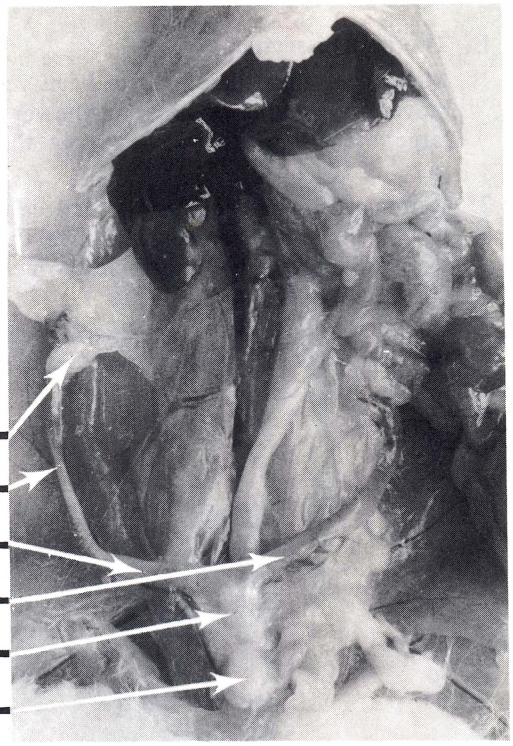


FIG 4.

Male.

12 Use scissors to remove the skin from around one testis. Pull the bladder towards you and notice the two tubes which loop over the ureters.

Use a seeker to follow one tube (a *vas deferens*) from the base of the bladder to a *testis.*

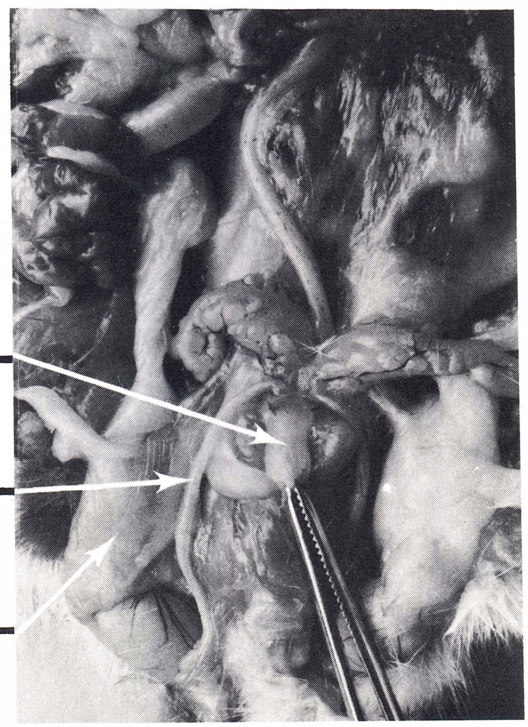


FIG 5.

E. Thoracic dissection

1. Make sure that the skin has been removed from the neck. Observe the very large blood vessels which supply the parts of the head.
2. Remove the ribs—figure 6—take care not to puncture the lungs. Notice the strong diaphragm and the "pipes" which pass through it.
3. Cut along the length of the neck and use a seeker to isolate the *trachea*. Follow it down to the lungs. Notice the collapsed oesophagus next to the trachea.
4. Notice the heart and its important blood vessels. Find the large vessels which lead to and from the lungs and the body.
5. Insert the blowpipe or glass tube into the trachea (make a small cut if necessary). Blow gently into the tube and notice the lungs expand.

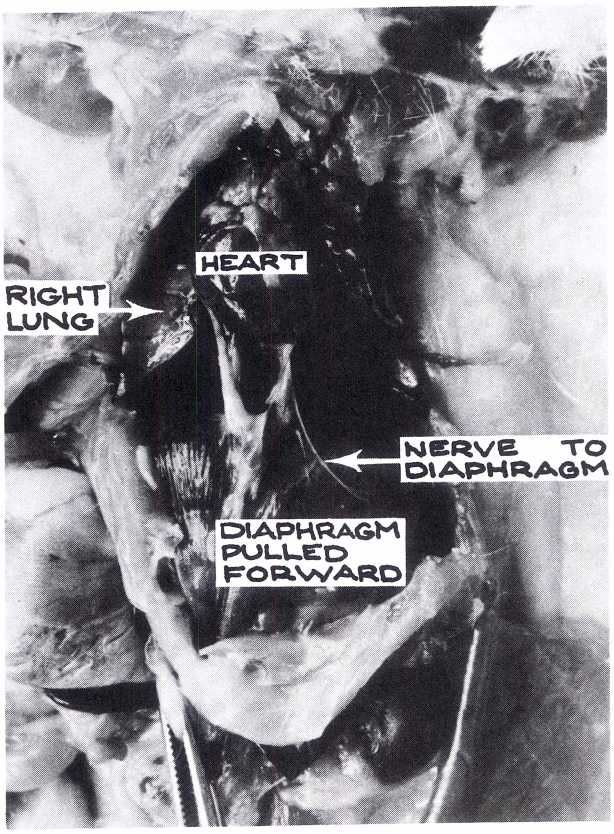


FIG 6.

Date	# Food Tests	Exercise

Materials

test tubes
iodine solution
Millon's reagent (or concentrated nitric acid and ammonium hydroxide)
benedict's solution (or sugar oil test paper or tablets)
Sudan III
starch solution
protein solution
various foods
glucose solution

Procedure

1. Number 5 test tubes 1-5 and place 5 drops of water in each test tube.
2. As you complete the various tests, record the resulting colour in the table provided.
3. To test tube No. 1 add 1 drop of iodine solution.
4. To test tube No. 2 add 3 drops of Benedict's solution and boil gently for two minutes.
   Caution: Liquids containing Benedict's solution should be heated very carefully and gently for they tend to spurt out of the tube.
5. To test tube No. 3 add a piece of test-paper or tablet.
6. To test tube No. 4 add 3 drops of Millon's reagent and boil gently.
7. To test tube No. 5 add 3 drops of Sudan III and shake.
8. Rinse the test tubes and then repeat the tests in turn with (1) glucose, (2) starch, (3) protein and (4) fat.
   From the results you have listed in Table I what reagent would you use to test for each of the food substances? Answer this question by completing table II.

TABLE I

Solution	*Iodine*	*Benedict's solution*	*Paper or tablet*	*Millon's reagent*	*Sudan III*
water					
glucose					
starch					
protein					
fat					

TABLE II

Food substance	+	*Test reagent*	→	*Resulting colour*
glucose	+		→	
starch	+		→	
protein	+		→	
fat	+		→	

Using Food Tests

1. Place a small quantity of unknown A in each of four test tubes.
2. Add 5 drops of water to each and mix the unknown with the water using a stirring rod carefully.

   Test this unknown with the 4 test reagents.

   Record your results by placing a + in the appropriate space in the table below whenever the test gave a positive result.
3. Test all other unknowns with the 4 test reagents and record your results.

When your table is complete, ask your teacher the names of the unknowns. From what you have learnt in this work, and from reading labels on foods did any of the reagents fail to give the test you might expect?

If so, name these and offer an explanation.

Unknown	*Glucose*	*Starch*	*Protein*	*Fat*
A				
B				
C				

Date	# Enzymes	Exercise
Materials	burner test tubes 50 cm^3 beaker glass-marking pencil **For Part I:** tile 3 pipettes red and blue litmus paper iodine solution	starch solution sugar test reagent **For Part II:** teat pipette ice rennin solution

Procedure

Part I. The action of an enzyme

1. Rinse your mouth with a small amount of water (no more than a teaspoonful) and place the mixture of water and saliva in the beaker. Test it with litmus paper. Is your saliva acid, alkaline or neutral?

2. Place 10 drops of saliva in a test tube and boil it for two minutes.
3. Label 4 test tubes 1-4 and stand them in the rack.

   Later you will be taking a drop of solution from each of these test tubes and placing each on the white tile.
4. To assist the test, mark the tile similar to the results table shown.
5. Add 5 drops of starch solution to each of the four test tubes.
6. To test tube no. 1 add 2 drops of dilute hydrochloric acid.
7. To test tube no. 2 add 2 drops of dilute hydrochloric acid and 5 drops of saliva.
8. To test tube no. 3 add 5 drops of saliva.
9. To test tube no. 4 add 5 drops of boiled saliva.
10. Warm each test tube by holding it in the palm of your hand for a minute or two. Do this at intervals during the exercise.
11. Place a drop of iodine in the 4 positions on the tile for time 1.

    To the first add a drop of solution from test tube 1.

    Similarly test a drop from each tube. (Use a separate pipette for each solution or be sure to rinse the pipette before using it in a different solution.)
12. Record results in the table by writing the colour obtained with each test.
13. Test the solution in each test tube at intervals of 5 minutes.

    Once one solution does not turn blue with iodine, this part of the exercise is completed.
14. Test each solution for the presence of sugar, and enter your results in the table.

	Time 1	Time 2	Time 3	Sugar present or absent
tube 1				
tube 2				
tube 3				
tube 4				

In what test tube did the solution eventually give no blue colour with iodine?

What did this tube originally contain? In which tube did the test indicate the presence of sugar?

What changes have occurred in this test tube?

Part II. The effect of temperature on an enzyme

You have already seen the effect of boiling saliva. In this exercise you will learn more of the effect of temperature on the activity of the enzyme.

Rennin is a constitutent of milk and will curdle milk.

1. Label three test tubes 1-3 and place 5 drops of milk in each.
2. To each test tube add 3 drops of rennin solution.
3. Test tube no. 1.
   Stand this in a beaker of crushed ice.
   Test tube no. 2.
   Gently heat the contents for a minute and then boil for a minute.
   Test tube no. 3.
   Hold this in the closed palm of your hand.

The enzyme in saliva is salivary amylase. Summarize your findings by completing the following:

Starch is converted to sugar by

This will not happen if is present.

This will not happen if the enzyme has been

4. Examine each test tube at intervals of five minutes and record your results by writing no change or the degree of coagulation. The enzyme rennin curdles milk and degree of coagulation is a measure of the activity of the enzyme. While waiting for the results, write out your design of the experiment mentioned at the end of this exercise.
   Make a general comment on the effect of temperature on the action of the enzyme rennin.

Design an experiment from which you could determine the range of temperature in which rennin will coagulate milk, and the temperature at which rennin acts most rapidly.

	Time in minutes					
	0	5	10	15	20	25
test tube 1 (ice cold)						
test tube 2 (boiled)						
test tube 3 (body temperature)						

Date	The Hydrolysis of Proteins	Exercise

Materials	
	4 test tubes; beaker; glass-marking pencil or labels; razor blade or scalpel; thermometer; pepsin; hydrochloric acid (dilute); egg white (boiled)

Procedure

1. Label the four test tubes and add 5 drops of water to each.
2. Cut from the egg white four cubes of size about 0·5 cm.
3. To test tube no. 1.
   Add a piece of egg white.
   To test tube no. 2.
   Add pepsin and a piece of egg white.
   To test tube no. 3.
   Add 5 drops of hydrochloric acid and a piece of egg white.
   To test tube no. 4.
   Add 5 drops of hydrochloric acid, pepsin and a piece of egg white.
4. Stand the four test tubes in water in the beaker and heat the water to 37°C. By adjusting the flame keep the water as near as possible to this temperature.

   Suggest a reason for keeping this water bath at 37°C.

5. Examine the test tubes at intervals throughout the lesson, and at the end of the lesson record any difference in the size of the pieces of egg white.
6. Allow the test tubes to stand in the water bath and examine them later in the day and again on the following day. Record your results.

Test tube	*Change at end of lesson*	*Change at end of day*	*Change after 24 hours*
1			
2			
3			
4			

7. What evidence is there that a chemical change has taken place?

What chemical change do you think has taken place?

What would you have to do to confirm your last answer?

What substances were placed in the test tube in which change occurred?

What does this tell you about the effect of acid on the action of pepsin?

Date	# Co-ordination	**Exercise**
Materials	You and two partners.	

Procedure

Part 1—By yourself.

1. Sit on a chair with one leg crossed over your other knee. Strike your crossed leg just below the knee cap, with the edge of the hand. Repeat this until some positive action results.
   What happened?

   What was the stimulus?

   What was the response?

   What was the effector?

Part 2—With a partner.

1. Look into the eyes of your partner, and ask him to close his eyes for a minute.
2. At the end of the time ask him to open his eyes and as he does look carefully at the pupils of the eyes.
3. What changes did you notice?
4. Now sit with your eyes closed and let your partner make the observations.
   Parts of the eyes have responded to a stimulus.
   What was the stimulus?

   What was the response?

Comment on the importance of this reflex action.

What is the colour of your partner's eyes?

This exercise shows the ways in which the body responds to outside stimuli.
Can we control the movements of the iris?
Can we control the "knee jerk"?

What name do we give to actions which we cannot control?

Part 3.
Work in groups of 3. Let A be the "guinea pig" while B and C both take measurements during the exercise and record the results.

1. Instructions to A.
   Sit comfortably in a chair with your arm resting on the desk. Face the palm upwards.
   Instructions to B and C.
   While A is sitting at rest B must count the number of breaths A takes in one minute. At the same time C takes the

wrist pulse of A. *Do not tell A when you start.* Make several practice counts so that you are sure that you are counting correctly. Make a final count and record your results in the "At rest" column in the table.

2. Instructions to A.
   Raise and lower your arms above your head rapidly 20 times and then resume your original position.

   Instructions to B and C.
   Count the pulse rate and number of breaths in a minute IMMEDIATELY after A stops exercising. Record the results.
3. Instructions to A.
   Run on the spot vigorously for a minute or two, and then quickly sit down in your original position.

   Instructions to B and C.
   Again count the number of breaths and the pulse rate in one minute. Record the results.
4. If time permits change duties and repeat the experiment.

   You could do it at home with one of the family!

What is the effect of exercise on
(1) the pulse rate?

(2) the breathing rate?

Can we control these actions?

In 1 Instructions to B and C it says, "Do not tell A when you start." Why is this instruction necessary?

You might well expect an exercise of this type to be included under the heading "Breathing" or "Heart Beat".

Suggest reasons for its inclusion under the heading "Co-ordination".

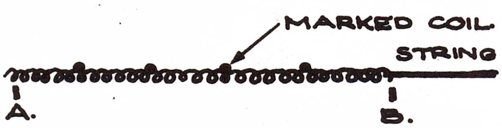
Student	*At rest*		*After moderate exercise*		*After vigorous exercise*	
	pulse	*breathing rate*	*pulse*	*breathing rate*	*pulse*	*breathing rate*
A	*/min.*	*/min.*				
B						
C						

Date	# Two Types of Waves	Exercise
Materials	2 partners 1 slinky spring chalk	masking tape piece of light cord (1 m)

Procedure

1. Use two partners to help you. Tie the cord to one end of the spring. Let one partner hold the string and then stretch out the spring in the corridor (or suitable space) to a length of 5 m.
2. The second partner marks 4 coils at about 1 m intervals with masking tape.

FIG 1.



3. Mark the positions of your end of the spring on the floor with chalk (A) and the other end (B).
4. Flick a pulse into the spring as in figure 2.

The pulse starts at A and proceeds towards B.

The direction A → B is known as the direction of propagation.

5. Watch what happens when the pulse reaches B.

What happens to the direction of propagation?

THE DIRECTION REVERSES

The pulse which travels back to A from B is known as the reflected pulse.

6. Figures 3, 4, 5 show different pulses you can send. Practise sending each

FIG3.

FIG 4.

FIG 5.

kind of pulse and cross out the wrong answers given to the questions below.

(a) To produce each of these pulses I flicked A

(i) across the direction A → B

(ii) in the direction A → B

(iii) up and down.

(b) The direction of propagation is

(i) A → B

(ii) B → A

(iii) to and fro.

(c) The marked particles in the spring vibrate

(i) A → B

(ii) B → A

(iii) at right angles to the direction of propagation.

8. Here are two correct definitions. *Transverse waves* (or pulses) are waves in which the particles of the medium vibrate at right angles to the direction of propagation.

Longitudinal waves (or pulses) are waves in which the particles of the medium vibrate in the same direction as the direction of propagation.

9. The pulses made in figures 2, 3, 4 and 5 are all

TRANSVERSE WAVES

10. Flick a pulse into the spring by pushing A sharply about ½ m directly towards B.

Does the pulse travel towards B?

YES

What do the marked parts of the spring do?

THEY MOVE BACK AND FORTH.

What type of pulse is it?

LONGITUDINAL

11. Practise sending longitudinal pulses into the spring.

FIG 6.

12. The diagram shows a spring stretched along a floor.

A movement of S from

S → P → S would produce a

pulse.

State two movements of S which would produce longitudinal pulses.

(i) S →

(ii) S →

13. When you are out in a boat fishing your float may bob up and down as the waves go past.

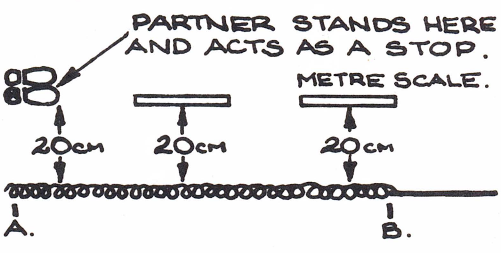
If this happens the waves have the properties of waves.

Date	The Amplitude of Waves	Exercise
Materials	2 partners slinky spring chalk	masking tape 2 metre scales 1 m light cord

Procedure

1. Stretch out the spring to about 5 m and mark the positions of the two ends A and B.
   Mark one coil with masking tape at about the middle of the spring.
2. Let one partner place two metre scales parallel with the spring and 20 cm away from it on one side.
   Place one rule about halfway along the spring and the other nearly at B.
3. Now let this partner stand 20 cm out from A on the same side of the spring as the metre scales and to the side of the spring. He will act as a stop as you move the end A. Check with figure 1.

FIG 1.



4. Flick a transverse pulse into the spring by moving end A to the stop and back again.
   How far does the end A move away from its rest position?

   Do the particles along the spring move as far from their rest positions?

   The greatest distance a particle in the spring moves from its rest position is called the *amplitude* of the wave.
   What was the amplitude of the pulse at A?

   What happened to the amplitude of the pulse as it travelled along the spring?

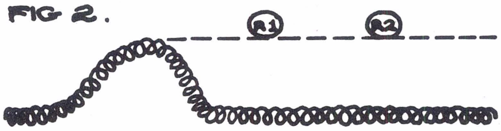
5. Try it again and check your answer.

6. Move the stop and metre scales out to 50 cm and send a transverse pulse of amplitude 50 cm.
   What happens to amplitude as the pulse is transmitted?

7. Flick a pulse like the one shown leaving A in figure 2.

Sketch the pulse as it passes (a) R_1
(b) R_2

FIG 2.



Do you think there is more or less energy involved in producing pulses of bigger amplitude?

8. Produce a longitudinal pulse.
How would you produce a pulse of larger amplitude?

Do this.
Sketch what you see.

9. Flick a pulse of this shape into the spring.

FIG 3.

Mark in on the diagram the
(i) direction of propagation.
(ii) amplitude.

Date	Changing the Speed of Waves	Exercise
Materials	metre rule 1 m light cord masking tape	stopwatch slinky spring

Procedure

In this exercise we will investigate three problems about the way in which pulses travel in a spring.

A. Does the tension in the spring alter the speed of waves in the spring?

B. Does the amplitude of a wave alter its speed?

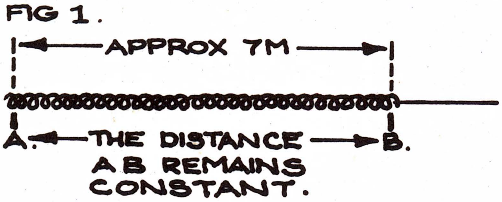
C. Does the shape of a pulse alter its speed?

We will study these three factors separately. As we study each one, the other two must be kept constant (unless, of course, we have already shown that they do not affect the issue). Thus, while we are investigating the effect of tension we must keep amplitude and shape constant.

A. The effect of tension on speed

1. Stretch the spring to about 5 m and mark the positions of the ends (A and B) clearly on the floor.
2. Set up a stop so that all pulses will begin with the same amplitude (say 30 cm).
3. With the stopwatch take the time for a pulse to travel from A → B. Practise your timing until you become skilful at starting and stopping the watch at the right instant. Now complete the table.

FIG 1.



4. Stretch the spring to 7 m. See figure 1. (The tension in the spring is now greater.)
   Complete three time trials for the same distance A B and with the same amplitude as in 3.
5. Repeat 4 for a stretch of 9 m.

Time trial	*Time*		
	Spring at 5 m	Spring at 7 m	Spring at 9 m
1			
2			
3			
Total			
Average time for distance A B =			

6. If a pulse travels the same distance (A B) in less time it must be travelling slower/faster/same speed.

State your conclusion about the speed of pulses in a spring as tension increases.
(Remember to include your controls.)

B. The effect of amplitude on speed

Now that we know that different tension affects the speed of a pulse what must we do when we investigate the effect of amplitude on the speed of a pulse?

1. Flick a transverse pulse of small amplitude into the spring.

   Now flick a pulse of much larger amplitude.

   Which travels faster—or do they travel at the same speed?
   Make your judgement and tick the statement you estimate to be correct.
   (i) Waves of bigger amplitude travel more slowly than those of small amplitude.
   (ii) Amplitude does not affect the the speed of a wave.
   (iii) Small amplitude waves travel more slowly than waves of large amplitude.

2. Complete time trials for three waves of small amplitude. *Remember that tension, shape and distance* over which you time the pulse must remain constant.

3. Do the same with three waves of large amplitude.

	Time	
Time trial	Small amplitude	Large amplitude
1 2 3		
Total		
Average =		

What is your conclusion?

4. Check your previous estimate (1).

C. The effect of shape on speed

In this problem you are required to carry out your own investigation and write your own report.

Here are a few tips.

(i) State clearly the conditions of your experiment. What are you measuring? What will you keep constant throughout your investigations?

(ii) Set out your results clearly and record them as you carry out the experiment.

(iii) State your conclusion.

Date	The Ripple Tank	Exercise
Materials	1 ripple tank glass rod (diam. > depth of water) glass slabs (rectangular, triangular)	

Procedure

1. Run approximately 2 cm of water into the tank and wait until it is still. Adjust the light to throw a clear shadow.
2. Drop 1 drop of water into the centre of the tank.
   Sketch what happens in figure 1.

FIG 1.

What shape are the pulses?

Does this show that the speed of a pulse is constant in the tank?

Why?

3. Produce a straight pulse by rolling the glass rod backwards and forwards quickly in water. Roll it only about 2 cm.

FIG 2.

Sketch what happens in figure 2. Label the direction of propagation, wave front, wave source, medium.

4. Place a barrier (glass slab on edge) in the water (about 30 cm from the wave generator).
   Watch what happens when the barrier is parallel to the oncoming wave. Observe and sketch what happens when the barrier is at an angle to the direction of propagation (fig. 3).

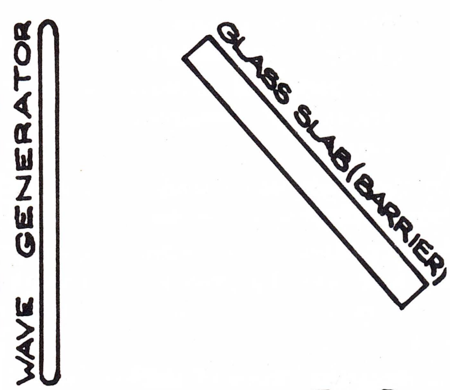


FIG 3.

What phenomenon occurs when the wave strikes the barrier?

Before you can measure the angles of incidence and reflection what will have to be drawn?

Draw this line and measure the angle if incidence (i) and the angle of reflection (r).

i = r =

What can be said about the two angles mentioned?

5. Dip the rod sideways in and out of the water with a steady frequency.
What do you call the distance between successive pulses?

6. Gradually increase the frequency of the wave motion.
What happens to the wavelength?

7. Which of the following statements is justified by your experiment (√ or ×)?
   (a) The wavelength decreases as frequency increases.
   (b) The wavelength is proportional to frequency.
   (c) The wavelength may be inversely proportional to frequency.
   (d) Velocity of a wave = frequency × wavelength.
   (e) The period of a wave decreases as frequency increases.

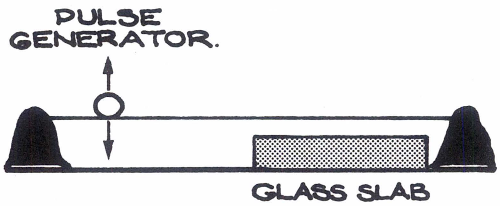
8. Tip the ripple tank slightly so that the water is shallow at one end.
Produce waves of constant frequency and note what happens to wavelength as the waves move into the shallow water.

As the water becomes shallow, wavelength

The frequency has been constant.
Assuming the relationship $v = f\lambda$ holds what can we say about the speed of water waves as the water becomes shallow?

9. Place a rectangular slab of glass in the water (see fig. 4). Produce waves of

FIG 4.



constant frequency and sketch what happens as the waves pass over the glass (fig. 5).

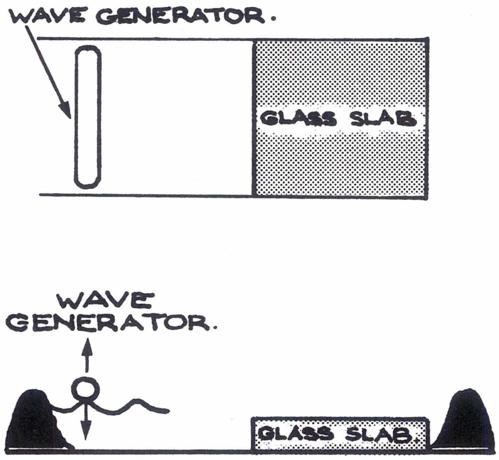


FIG 5.

10. Repeat with a triangular piece of glass and mark on your sketch any change in the direction of propagation.

Put in the sheet for your sketch here

11. What do we call the change in direction of a wave as it passes obliquely from one medium to another?

What causes the change in direction?

Date	# Sound	Exercise
Materials	1 tuning fork 100 cm^3 conical flask bell (or two screws tied together)	rubber bung stopper plus delivery tube clip watch

Procedure

1. Strike the tuning fork on the bung. Watch the prongs and listen for the sound. Bring the prongs up to just touch your cheek.
   What are the prongs doing while the fork is sounding?

   What happens to the prongs as the sound dies away?

2. While the tuning fork is still sounding hold it upright and firmly on the bench top.
   What happens?

3. To reach your ear the sound must be travelling through air.
   Describe one everyday example which suggests that sound also travels through solids.

4. Lay your ear on a smooth bench top (or door) and scratch the surface of the bench about 4 feet away from your ear. Lift your head away from the bench and make the same scratching movement on the bench.
   (a) Why is the sound different?

   (b) Which sound is louder?

   (c) What does this suggest?

5. Is the assumption that sound waves are longitudinal waves supported by your answer in 4 (c)?

   Why?

6. Hold your watch close to your ear. Now move it slowly away and measure the distance at which you can no longer hear your watch ticking. Record your answer. Repeat with your other ear. Maximum distance:

Left ear	*Right ear*

7. Now lay your ear on the bench. Place the watch flat on the bench and listen for the ticking. Slide the watch along the bench top. How far from your ear can you place the watch and still hear it?

Left ear	*Right ear*

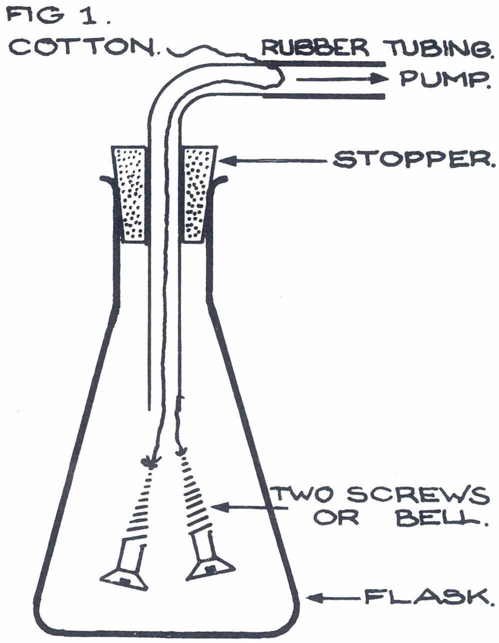
8. What do your results in 6 and 7 show?

9. Hold a pencil in your teeth and tap the far end. Now hold the pencil about the same distance from your ear and tap it again.
Which sound is louder?

Is there a difference in the nature of the sound?

Does it just sound louder or is it a louder *and different* sound when held in the teeth?

Explain the difference.



10. Set up the apparatus in fig. 1.
11. Shake the flask and listen for the sound of the bell. (It should *not* strike the glass.)
12. Attach the end A to a filter pump and pump the air from the flask.
13. Clip the tubing and remove the pump connection.
14. Shake the flask gently.
Describe the sound the bell makes.

Do you think sound would travel through a *complete* vacuum?

Why?

When a man walks on the moon will he hear any sound?

Why?

Date	The Speed of Sound	Exercise
Materials	tin can (e.g. rubbish bin) pendulum stopwatch	tape measure (30 metres) thick stick (e.g. baseball bat)

Procedure

1. Adjust the length of the pendulum to 1 m.

   Check the time for 20 oscillations with the stopwatch and record your results.

Time for 20 oscillations	=	s
Time for 1 oscillation	=	s
Time for pendulum to make one swing from A to B (see fig. 1)	=	s

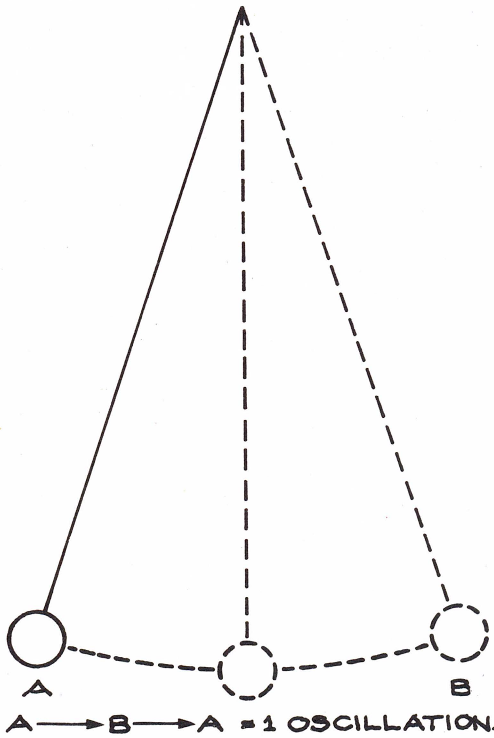
2. Move to a suitable place in the school-yard with the tin, the stick and the pendulum. (You will need a spot in one corner of the yard with a clear walk away from the spot or about 120 metres.
3. Practise hitting the tin as the pendulum bob reaches A, then B, then A, etc. This way you should be striking the tin every second.
4. (Read all the instructions in this step before you act.)

   Have your partner move away from the tin watching the strike and listening for the sound.

   He should keep moving until the sound and the sight of the can being struck are simultaneous.

   When this happens he should stop and mark his position.

   When you and your partner are clear about the requirements you begin beating and he begins walking.
5. Change over. You walk away, watching and listening while your partner beats the tin at 1 second intervals.



6. Mark your position when sight and sound seem simultaneous.
7. Measure the distance between the tin and the two positions.

Your distance	=	m
Your partner's distance	=	m
Average	=	m

8. The sound has taken 1 second to travel from the can to the listener.

Thus sound travels at   metres per second.

9. What would happen to your answer in 8 if a strong wind was blowing from can to listener?

10. A boy is watching a man chopping wood.

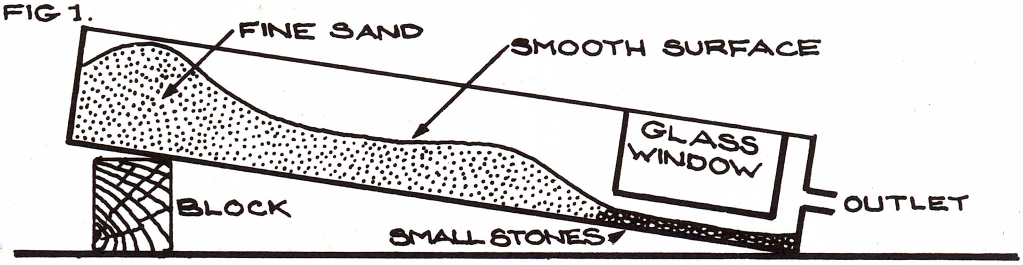
The sound of the axe seems to reach him at the same instant as the axe appears to hit the wood.

How far away from the axe could he be?

Date	Transport and Deposition — by Water	Exercise
Materials	stream table pebbles 3 pieces of wood about 60 cm x 5 cm x 5 cm fine sand } different coarse sand } colours	

Procedure

FIG 1.



This exercise is divided into 4 parts.

A. The effect of the velocity of a stream on its carrying capacity.

B. The effect of slope on stream formation.

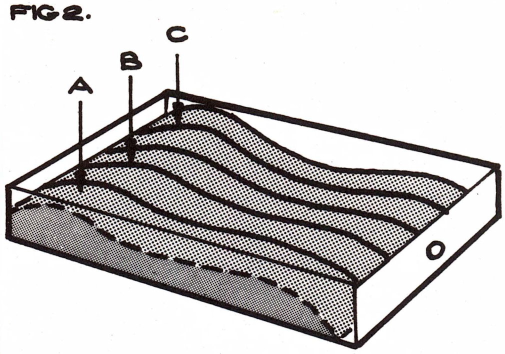
C. The formation of meanders.

D. The formation of a delta and an alluvial fan.

A. The effect of the velocity of a stream on its carrying capacity

1. Place fine sand in the stream table and build a hill of mixed fine and coarse sand as in figures 1 and 2. Smooth the sand.
2. Place one of the pieces of wood under the hill end of the table.
3. Allow water to flow very slowly onto the hill at A for about 5 minutes. Turn off the water and examine the hillside.
4. Allow water to flow at medium speed onto the hill at B for the same time as in 3. Turn off the water and examine the hillside.

FIG 2.

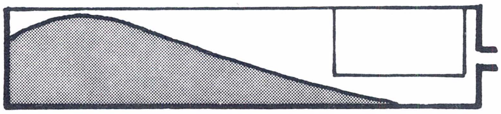


5. Allow water to flow very rapidly onto the hill at C for the same time as in 3 and 4. Turn off the water and examine the hillside.

   What can you say about the streams cut at A, B and C?

   What do the streams tell you about the amount of material shifted by the fastest stream?

FIG 3



B. The effect of slope on stream formation

6. Arrange the sand as in figure 3.
7. Allow the water to flow at medium speed onto the hill at A (as in figure 2) for 5 minutes. Notice how far the tap is turned on, for you will want water to flow at about the same speed in the next two parts of this exercise.
8. Turn off the water and observe the land surface.
9. Raise the hill end of the table with the 5 cm block. Allow the water to flow at about the same speed as in 7, onto the hill at B (as in figure 2) for 5 minutes.
10. Turn off the water and observe the land surface.
11. Raise the hill end of the table to 15 cm and allow water to flow at about the same speed as in 7 and 9 onto the hill at C (figure 2) for 5 minutes.
12. Turn off the water and observe the land surface.

    What can you say about the effect of the water at A, B and C?

    The stream cut on the steepest slope is than that on the other two.

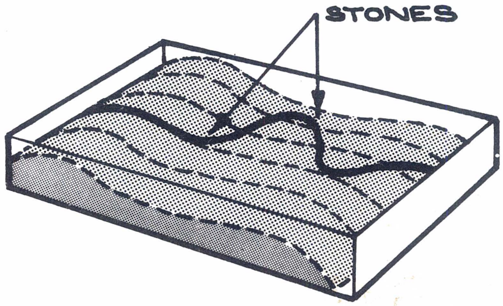
    How does the slope affect the velocity of the stream?

    What can you say about the slope of the stream, velocity of the stream and the amount of material carried from the hillside?

C. The formation of meanders

13. Arrange the stream table as in figure 3 and with your finger mark a stream as in figure 4. Place stones beneath the

FIG 4.



surface in the positions indicated.

14. Allow the water to run slowly onto the hill at the source of the stream. Allow it to run for at least 5 minutes.
15. Examine each bend carefully. Describe what you see, using sketches to help you, and explain what happens.

D. The formation of a delta and an alluvial fan

16. Arrange a damp mixture of fine and coarse sand as in figure 5. Fill the "lake" with water.

17. With your finger mark out a stream about 2 cm deep. Make it near the edge of the table holding the inspection window.
18. Let water flow gently onto the source of this stream and observe what happens for several minutes.
19. Adjust the flow of water so that it trickles very slowly and allow it to trickle while you complete your record.

    Mark on figure 5 the places at which most sand is deposited.

    What is similar about these places?

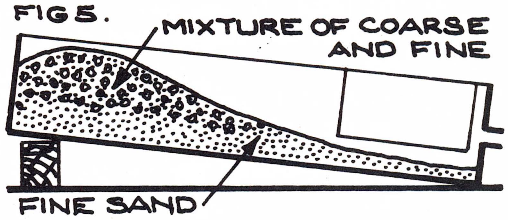
    What happens to the velocity of the stream at these places?

    What does this tell you about the conditions under which sediments are deposited from a stream?

20. Look at the surface and the depth of the deposits. How have they changed?

    Compare the alluvial fan and delta with diagrams and photographs in various reference books.

FIG 5.



21. When you have the opportunity, rebuild the hill as in figure 4 and practise turning the water on faster and slower to build up layers which are fine and coarse. Which type of sediments would be deposited on the delta when the stream was just trickling?

The Settling of Sediments

Materials

tall jar
gravel
sand
loam
clay

Procedure

1. Mix together the gravel, sand, loam and clay.
2. Place about 5 cm of the mixture in the jar, almost fill the jar with water and allow it to stand. Watch the jar as the particles settle. The first particles to settle are the
3. After this has stood for a few minutes pour off about 20 cm^3 into a beaker. Allow the jar to stand for the remainder of the lesson, observing it from time to time.

4. Filter the 20 cm^3 sample which you decanted. Was the filtrate clear or cloudy?

5. Place 10 drops of filtrate in each of two test tubes. To one add 2 spots of sodium chloride. Shake it and allow it to stand.
6. Look again at the jar of water and soil. Most of the particles have settled out.

   The   particles are on the bottom. The   particles are at the top. This shows that the   particles settle first.
7. Examine the two test tubes. What difference can you see?

   The finest particles in the mixture were so small that they passed through a filter paper. They remained in suspension and such small particles are called   particles. In the presence of sodium chloride the colloidal clay particles   and eventually

   This exercise illustrates a natural happening where

Contour Ploughing

Materials

kitchen fork or
coarse comb
sprinkler (rose)
water supply
large pile of sand

Procedure

1. This exercise can be done outside on the ground or lawn, or inside if some tray has been made to keep water and sand in one place.

2. Make a pile of sand about 80 cm at the base and about 45 cm high.
3. Allow water to flow through the sprinkler onto the top of the hill.

   Comment on what you see.

4. Reform the hill and "plough it" with the fork by making furrows from the top to the bottom.

   Let it "rain" again and comment on what you see.

5. Reform the hill and this time "contour plough" it by making furrows around the hill. Let it "rain", and comment on what you see.

   In which case did the water run off most rapidly?

   In which case was the most sand carried away?

   Which is the most successful method of ploughing to prevent soil erosion?

6. Think of other ways you can use this simple model to demonstrate ways of preventing erosion by running water. Outline what you could do, record your findings and summarize your results.

Put in the sheet for your sketch here

Date	Transport and Deposition— by Wind	Exercise
Materials	electric fan newspaper coarse sand	fine sand dust protractor

Procedure

1. Cover the bench with newspaper and place the fan at one end.
2. Thoroughly mix the sand and dust together.
3. Switch on the fan and adjust it to half speed.
4. Toss handfuls of the mixture in front of the fan.
5. Examine the particles which settle on the paper at different distances from the fan.

   What do you notice about the size of the particles as you go further from the fan?

6. Repeat the above procedure but use the fan at higher speed.

   Are particles carried further from the fan?

   Is the order of particles on the paper the same?

   The particles are carried further than the particles.

   The velocity of the wind is an important factor in the transport of particles by wind. Our experiment shows that

7. Repeat the procedure using a damp mixture.

   What happens this time?

8. When sand is carried by the wind it is deposited and builds up by fences, trees and bushes. Explain this.

   How could you use your model to demonstrate this?

9. If you were at the beach on a windy day where would you prefer to sit and why?

The Formation of Sand Dunes

1. Place a layer of dry sand about 3 cm deep and 6 cm wide on one end of the paper on the bench.
2. Move so that you can blow at the level of the bench into the sand.
3. Blow gently for a minute or two until the sand has formed into a shape which remains.
4. Measure the approximate angle the sand makes with the paper on the side nearest you (windward side) and away from you (leeward side).

   Angle of slope on windward side =

   Angle of slope on leeward side =

   Sketch the shape of the dune you formed and mark in these angles.

5. Repeat this several times.

   What can you say about the shape of the dunes formed?

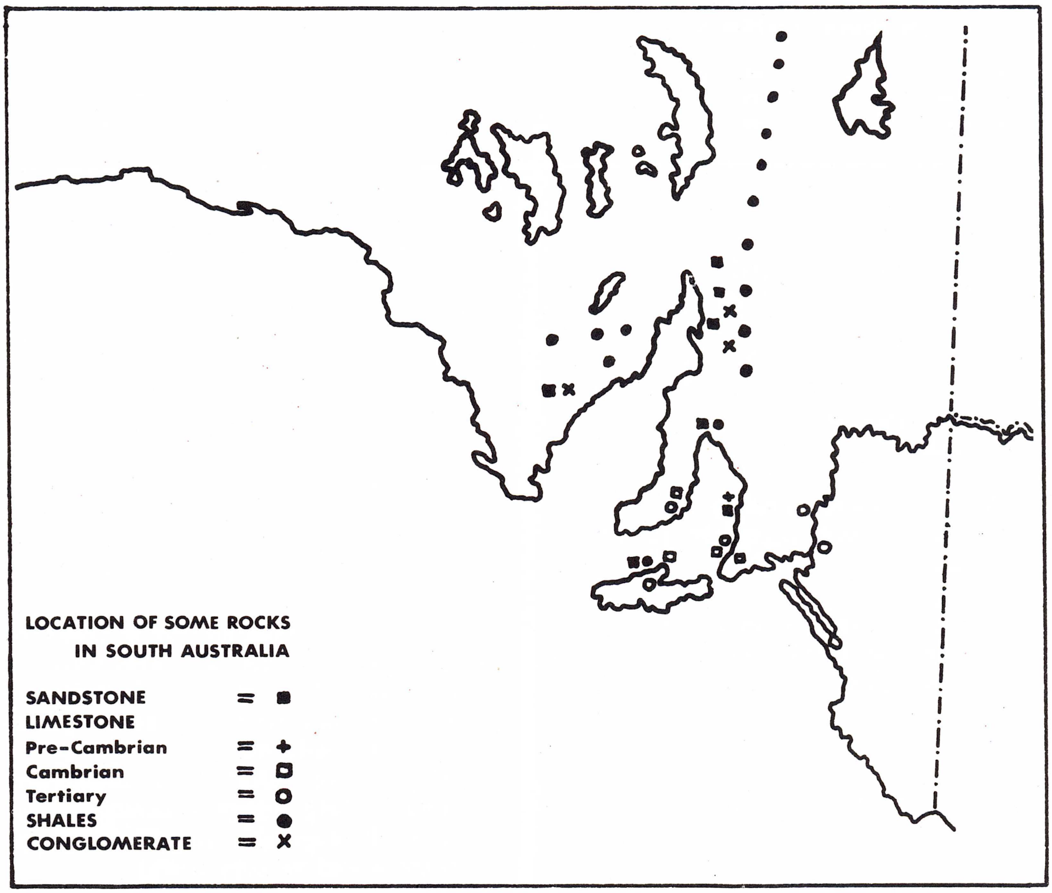
6. As you blow harder the whole dune shifts along.

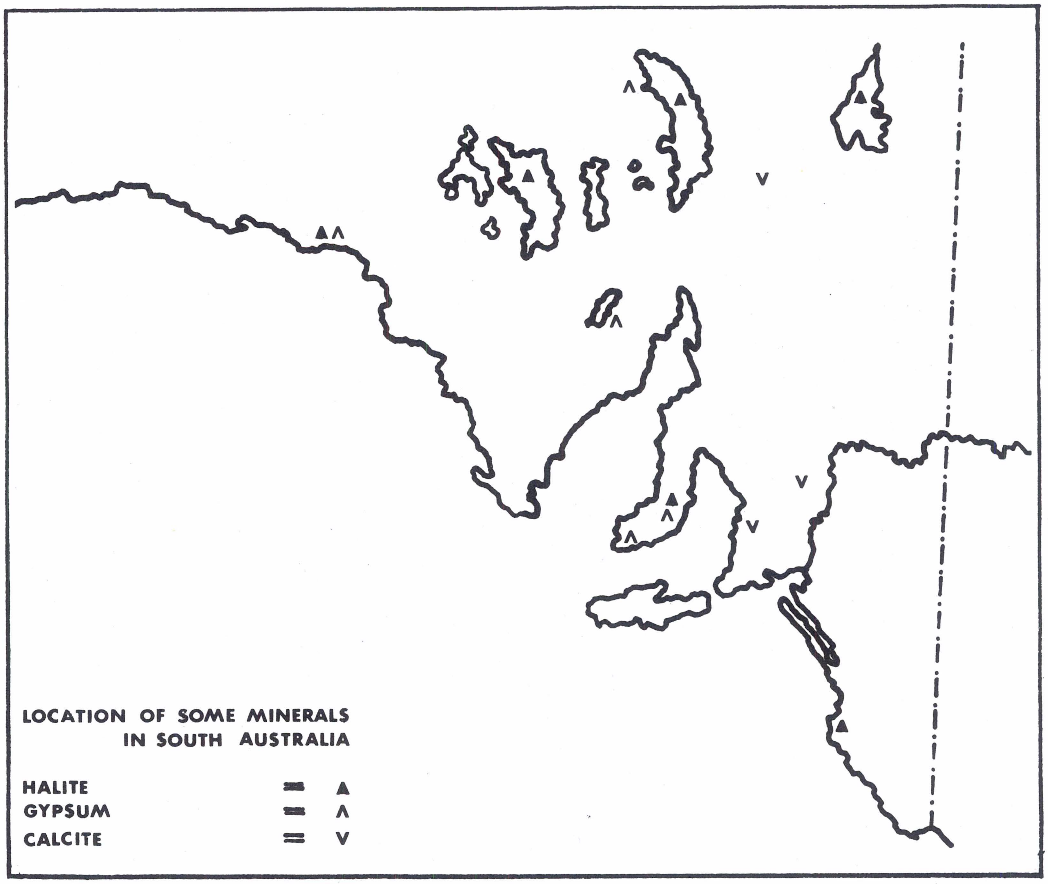
   Under natural conditions how could this drift of sand be prevented?

Date	# Rocks and Minerals	Exercise
Materials	field notebook pencil hammer map of area	bags for specimens labels camera

The maps show the location of some of the main rocks and minerals which occur in South Australia.

The best guides to the location of different rock types are the geological maps obtainable from the Mines Department in your State. Although these maps include more information than you require at this stage, you will be able to follow them quite easily.





Look for these sedimentary rocks
- sandstone
- limestone (Pre-cambrian)
  - (Cambrian—fossiliferous)
  - (Tertiary—also fossiliferous)
- conglomerate
- shales

Some common minerals are
- halite, which occurs in recent salt lakes;
- gypsum;
- calcite, which is found wherever fissures or cracks in limestone are mineralized.

On page 147 you will find the beginnings of a report on a field trip to Hallett Cove. If you can go there, so much the better, for there is a great deal to see there. If not, you can still use pages 147-148 as a model on which to base your reports on your own geological investigations.

Different types of rocks and minerals occur in different parts of the State. The following lists give you some idea of those which are most common in certain areas.
Perhaps you could arrange to exchange samples from your area with someone in a quite different area. In this way you will build your collection and help others to build theirs.
What other information could you send to help others understand your area? Photographs, simple maps and notes would be very useful.

Date	Fossils	Exercise
Materials	notebook and pencil collecting box lined with cotton wool	scraper cellulose tape

Procedure

Most of the fossils readily found are animal fossils. The younger fossiliferous rocks are the best to study for you can see the nature of the fossils better in these.

Do not expect to obtain perfect specimens like those from the collection held at the South Australian Museum which are photographed here, but you may be fortunate enough to find a few of these.

Plant fossils often occur in coal deposits. If you live in South Australia, the best source of plant fossils is Leigh Creek.

Other places where you can find fossils are marked on the map.

1. Look out for newly exposed rock faces (road cuttings, quarries, cliffs).
2. When you see a fossil, scrape away the surrounding rock, taking care not to touch the fossil itself. (A light hammer with a pointed end can be useful, but should be used with great care so as not to break the fossil.)
3. Stick an identification number to the fossil with cellulose tape.
4. In your notebook record the exact location where each fossil was found, noting the nature of the surrounding rocks. A photograph is ideal.
5. Mark the places where you found your fossils on the map.

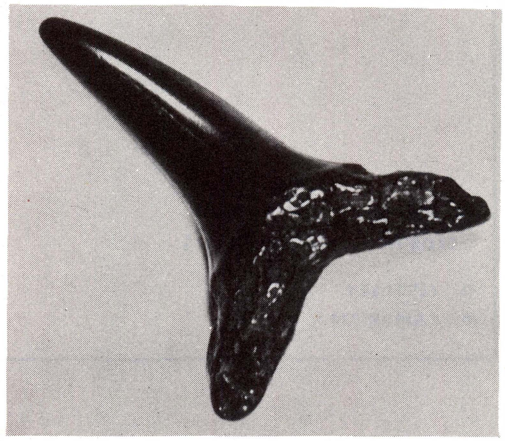


Fig. 1. A shark's tooth

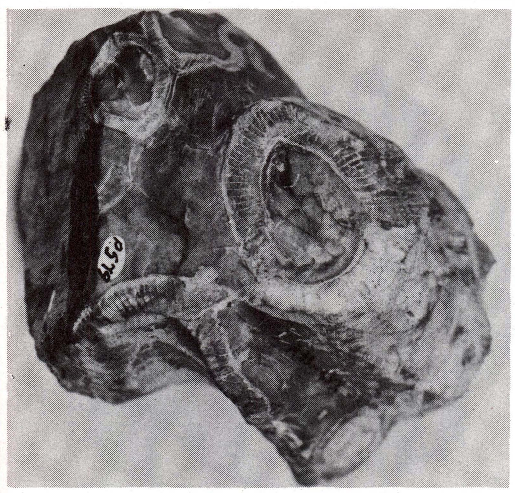


Fig. 2. Archaeocyatha

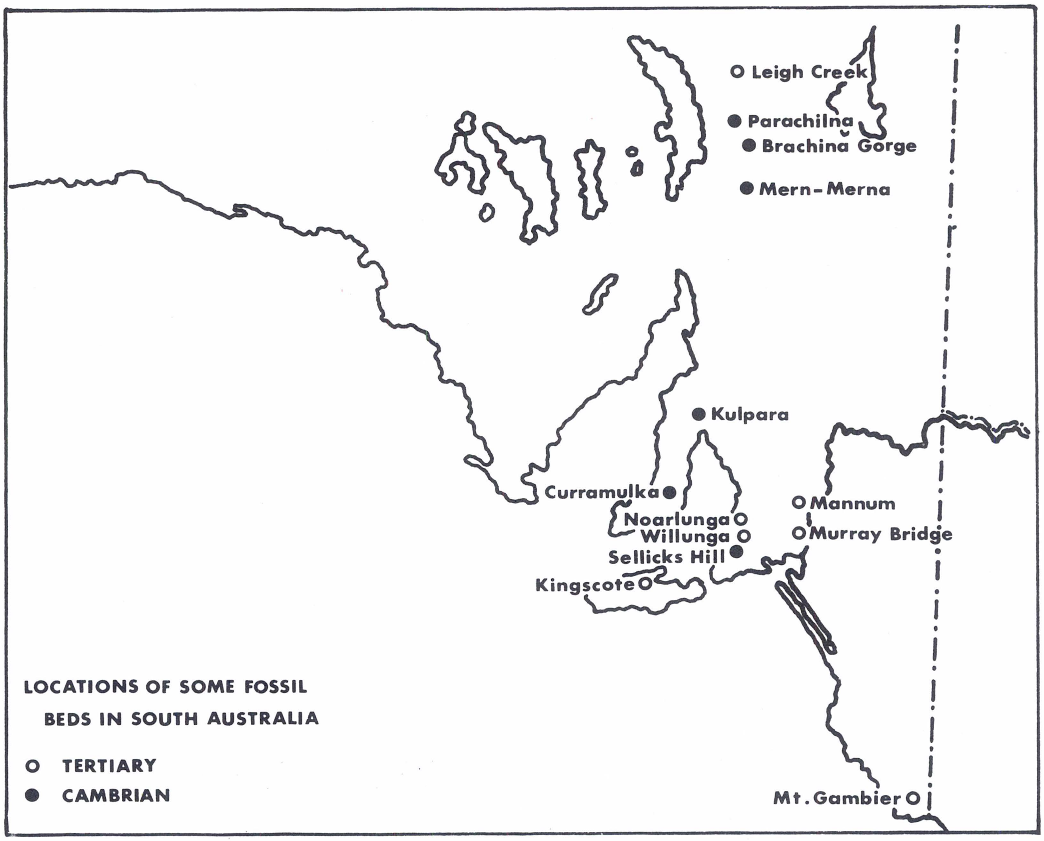


Fig. 3. Dicroidium

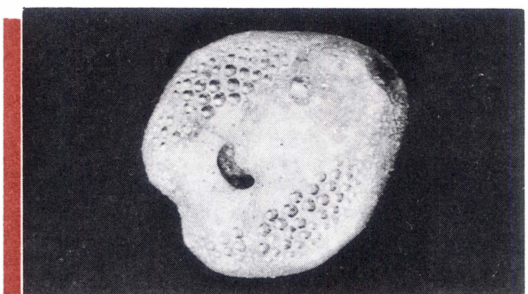
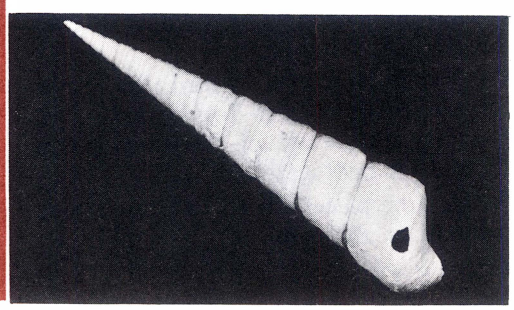
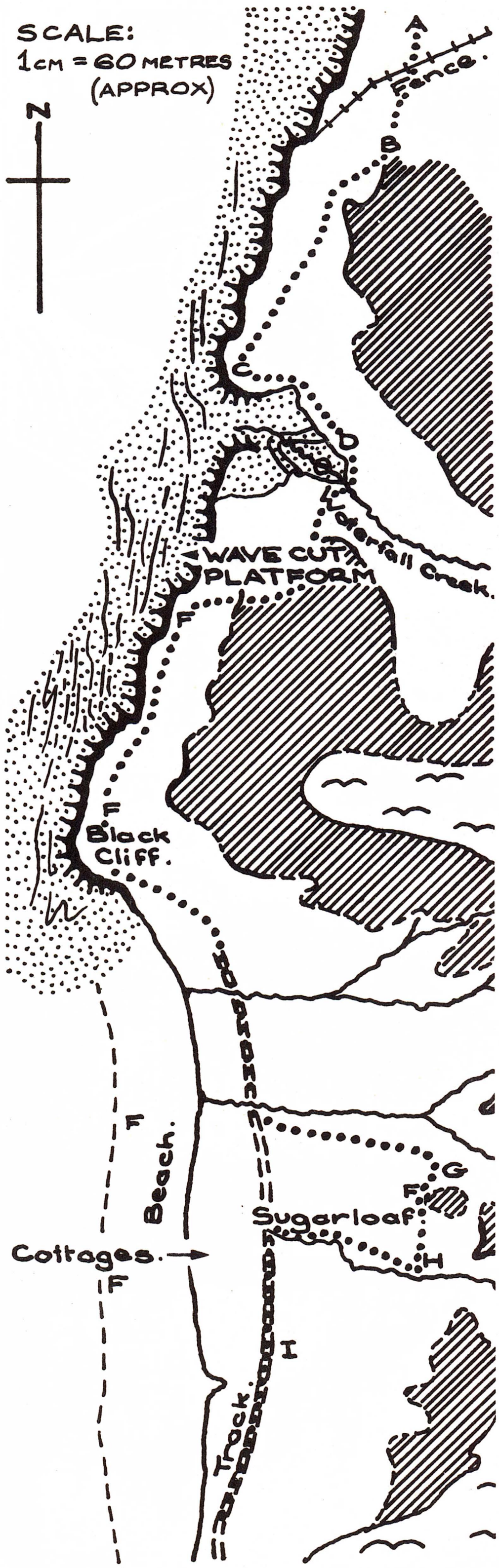


Fig. 4. Lovenia

Fig. 5. Turritella





Date	Exercise

An Excursion to Hallett Cove

Materials See *Rocks and Minerals*, page 143, and *Fossils*, page 145.

Procedure

1. It will be necessary to visit this area more than once to understand all of the features you see. This exercise points out features related to glacial deposits.
2. *Before you go:* Study the map carefully so that you will be familiar with many features even before you reach them.

   Outstanding features are discussed here according to the lettering on map, figure O. Take photographs if possible and include them (or diagrams) in the spaces provided.
3. A. Starting point.

   B. Hard fossil-bearing limestone. The beds beneath this layer are much softer than the limestone and they have been eroded away.

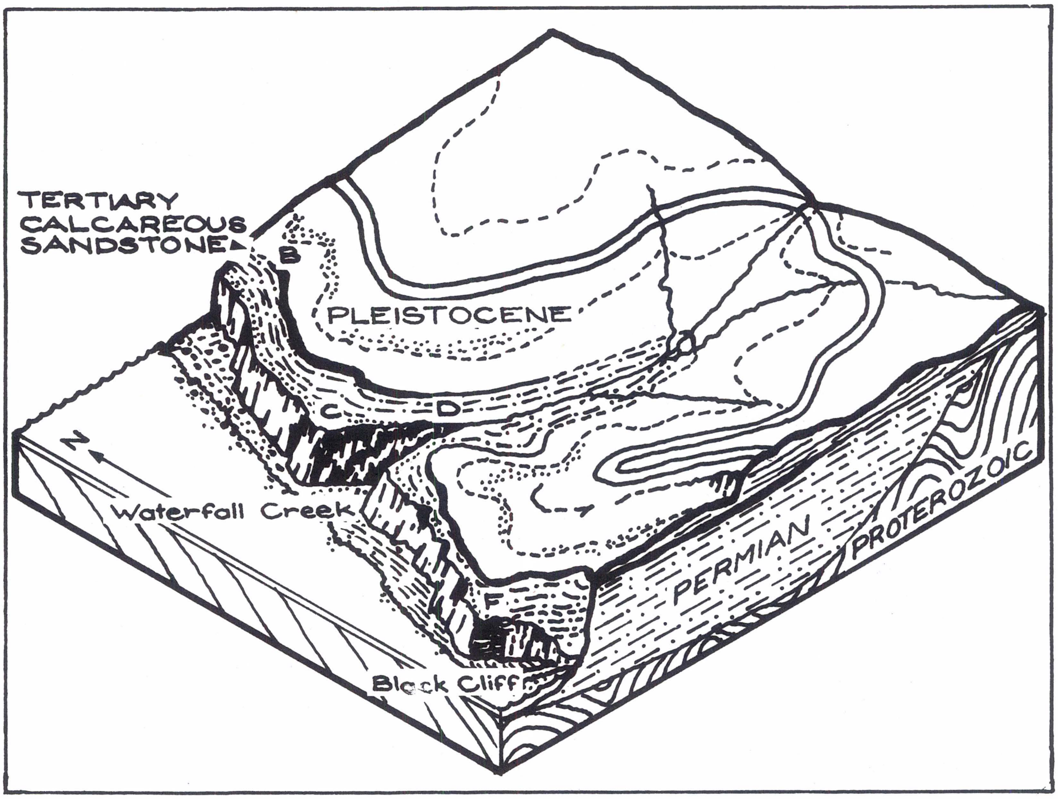
   C. Waterfall Creek.

   Notice the very old rocks which have been bent or folded. These are covered by glacial deposits and the *unconformity* is clearly visible.

   D. From this point observe the *wave-cut platform*.

   E. Striated pavements:
   Here exposed ancient rocks show the scratch marks or striations caused when the glacier moved over them.

   F. Erratics:
   These are some of the boulders which have been carried in the glacier and dumped as it melted.



G. Sugar loaf hill:
The sediments here are also of glacial origin. Notice the bedding and the way in which some sediments have been eroded more than others.

To the seaward side of the large sugar loaf hill notice beds containing erratics of various sizes.

Cross bedding is also shown.
Look away from the sea and notice the beds of mottled (red) laterites.

H. Pause here and look away from the sea to the "Badlands" where characteristic features of erosion can be seen.

I. Varves:
A small outcrop of fine glacial deposits in which the graded sediments can be seen.

4. What else did you see? Put letters on the map at the appropriate points.

J

K

L

M

Put in sheets for your own notes, maps and photographs here

Date	The Museum	Exercise
Materials	notebook and pencil any of your own specimens you would like to identify	

Procedure

You can spend hours and hours looking at the various displays at the museum.

This exercise directs you to Minerals, Rocks and Fossils. You could spend one visit looking at all of these or you may make a separate visit for each. You could use this collection to help you identify specimens you have collected. Study the plans shown.

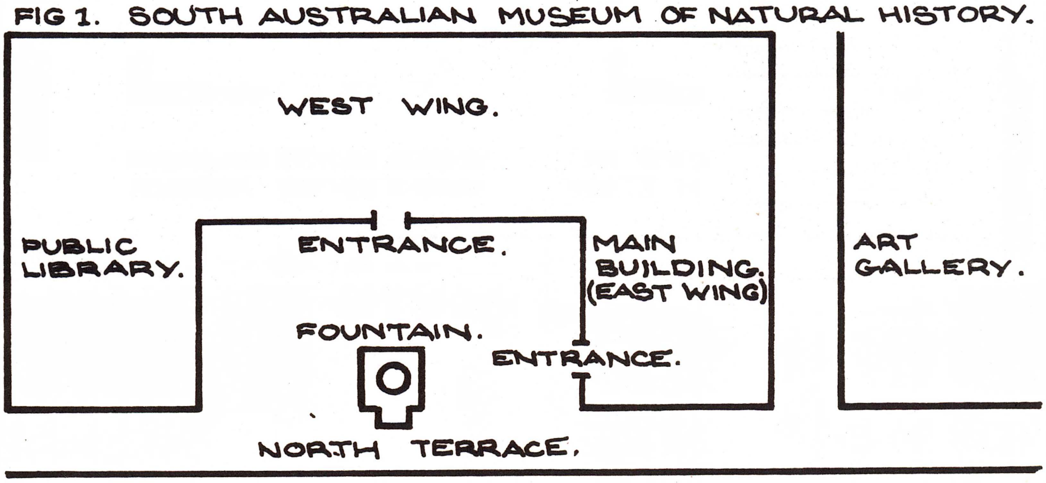
Minerals:
Two different displays are offered. M_1 and M_2 on the plan over the page.

M_1. Case 1—Mineral quartz, feldspar and mica, constituents of granite.

Case 2—10—Mineral structure and various examples of minerals arranged in groups according to shape, formation, aggregation and so on.

M_2. These cases show the variety in form of many minerals. In particular notice calcite (C), gypsum (G), halite (H), quartz (Q), feldspar (O) and mica (M).

FIG 1. SOUTH AUSTRALIAN MUSEUM OF NATURAL HISTORY.



Rocks: See R on plan.

Examples of igneous, metamorphic and sedimentary rocks are displayed. Notice in particular—

RW: *Weathering of granite.* Samples of unweathered granite and various stages in its weathering are shown.

RS: *Sedimentary rocks.* Types of particles from which sedimentary rocks are made are set out. This is followed by a large range of types of sedimentary rocks.

Fossils: See F on plan.

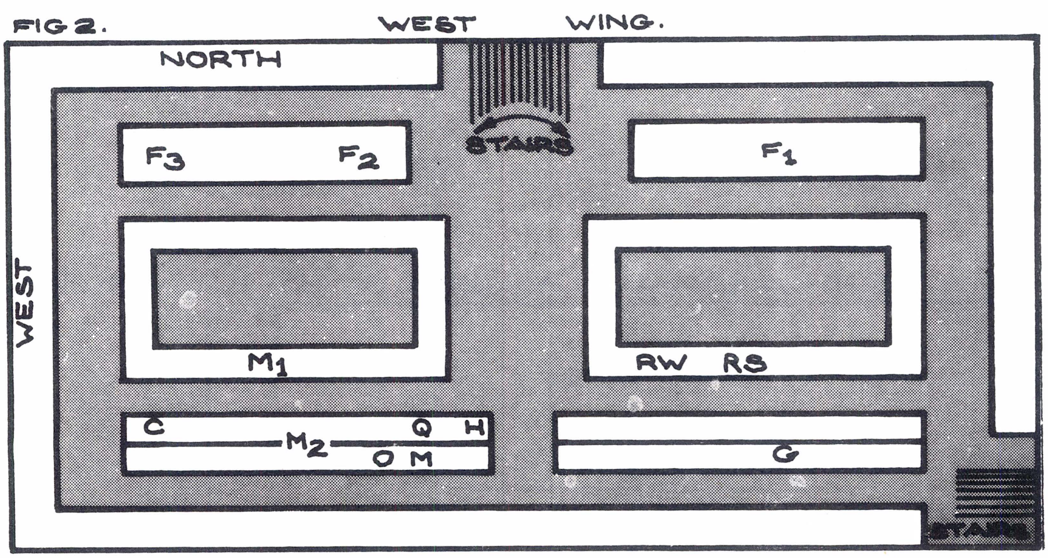
This display is of special interest for not only are fossils from all parts of the world displayed, but coloured pictures showing at least one animal from each group are included. These pictures help you to appreciate the kinds of living things which existed millions of years ago.

F_1 : 12 double trays show samples of rocks and fossils from the Cambrian period to the Jurassic period.

F_2 : 8 double trays of fossils from the Jurassic period to recent time.

F_3 : 6 double display trays showing fossils of special interest.

FIG 2.



Date	Allotropes of Carbon	Exercise
Materials	dry cell, torch globe and connections test tube burner filter paper filter funnel glass rod	25 cm^3 beaker holder litmus solution graphite—flakes rods, e.g. from pencils coke

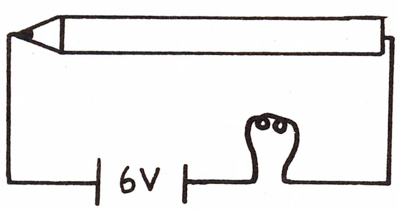
Procedure

A. Graphite and diamond

1. Examine the models of diamond and graphite crystals. Note that each carbon atom in the diamond lattice is attached to other carbon atoms (remember this is only a small part of the lattice—examine an atom away from a face).

   The graphite lattice consists of successive layers. Each atom in a layer is bonded to other carbon atoms. The fourth bond joins atoms in different layers but there is little force of attraction between the layers.
2. Examine a sample of graphite flakes. Note their feel.

3. Use the "lead" of a pencil to complete the circuit shown.



N.B. Only low voltage, e.g. 6-12 v must be used.

What does this show?

In what respect is this an unusual property?

4. Hold a piece of pencil "lead" in a bunsen flame.
   What does this show?

B. Lampblack

5 Adjust the air hole of a bunsen flame so that the flame is luminous and hold a test tube in the flame. What is the soft black deposit which forms?

Suggest why this deposit forms when the air hole is closed but not when it is open.

C. Coke

6. Examine the piece of coke provided.
   Describe its appearance.

D. Charcoal

7. Place some small pieces of wood (e.g. a tooth pick broken in two) in a test tube. Loosely stopper the test tube and heat strongly.
   What happens?

8. Allow the tube to cool on the asbestos mat.
9. Remove and examine the pieces of charcoal. Describe its appearance.

10. Using tongs hold a piece of charcoal in the bunsen flame. What happens?

11. Place 15 drops of litmus or methylene blue solution in two separate test tubes.
12. Filter one solution through a filter paper into a 25 cm^3 flask. Comment on the appearance of the filtrate.

13. Add 4 spots of charcoal to the remaining solution and shake it. If litmus is used, warm the test tube.
14. Filter the solution into a 25 cm^3 flask. Comment on the appearance of the filtrate.

    The coloured matter is said to have been *adsorbed* on the surface of the particles of the very porous charcoal.

Date	Some Reactions Which Produce Carbon Dioxide	Exercise

Materials

burner	calcium carbonate
test tubes	sodium bicarbonate
teat pipette	lead carbonate
candle	zinc carbonate
limewater	copper carbonate
dilute hydrochloric acid	sodium carbonate
sodium carbonate	

Procedure

Test: Last year you established that carbon dioxide will cause a solution of limewater to become milky. This is used as a test for carbon dioxide.

A. Burning carbon compounds

1. Place 3 drops of limewater in a test tube.
2. Light a candle. Depress the bulb of a pipette, hold the tip just above the flame and release pressure on the bulb.
3. Bubble the gas through the sample of limewater. Repeat 2 or 3 times if necessary.

   What happens to the limewater?

   What can you infer?

4. Repeat the same procedure using a bunsen flame instead of a candle.

B. Acid on a carbonate

5. Place 3 drops of limewater in a test tube.
6. In another test tube place 2 spots of sodium carbonate and add 3 drops of dilute hydrochloric acid.
7. Use a teat pipette to remove some of the gas and bubble it through the limewater.

   What happened?

   What did you conclude?

   Write the equation for the reaction of the acid and carbonate.

8. Repeat using a sample of calcium carbonate instead of sodium carbonate.

   What happened this time?

C. Acid on a bicarbonate

9. Repeat procedures 6-8 using sodium bicarbonate.

   What was the result?

   Write the equation for the reaction.

   Would you expect the same result if different acids were used?

   Explain why.

D. Heat on a carbonate

10. Place 3 drops of limewater in a test tube.
11. Place 2 spots (●●)of lead carbonate in a dry test tube and heat.
12. Remove a sample of the gas from the test tube and bubble it through limewater.
    What can you conclude?

    What is the colour of the residue?

    What do you think it might be?

    Write the equation for the reaction.

13. Repeat procedures 10-12 with samples of the carbonates of zinc, copper, sodium, potassium and calcium and fill in your results in the table.

E. Heat on a bicarbonate

14. Place 3 drops of limewater in a test tube.
15. Place 2 spots of sodium bicarbonate in a dry test tube and heat the test tube.
16. Remove a sample of the gas and test for carbon dioxide as previously.
    What was the result?

    Write the equation for the reaction.

    Explain why drops of water appear on the upper inside of the test tube.

Carbonate	*Limewater test (yes or no)*	*Residue and colour*	*Equation if decomposition occurs*
zinc			
copper			
sodium			
potassium			
calcium			

Date	A Preparation of Carbon Dioxide and some of its Properties	Exercise

Materials		
	2 25 cm^3 flasks	two-holed stopper for flask
	splint	solid stopper for flask
	burner	teat pipette
	test tubes	5 cm magnesium ribbon
	delivery tube	6 marble chips
	evaporating dish	dilute hydrochloric acid
	corks	concentrated hydrochloric acid

Procedure

1. Place the marble chips in a 25 cm^3 flask and assemble the delivery tube as shown in figure 1.
2. Fill 4 test tubes and the second 25 cm^3 flask with water.
3. Fill the pipette with concentrated hydrochloric acid.
4. Cover the marble chips with dilute hydrochloric acid and replace stopper.
5. Fill the test tubes and flask with carbon dioxide in turn by displacement of water. Add concentrated acid drop by drop if necessary. Stopper each container.
6. Write the equation for the reaction which occurred.
7. Smell the gas in one test tube. What can you say about
   (1) the colour?
   (2) the odour?
8. Remove the cork from one test tube of the gas, add a few drops of water, replace the cork and shake vigorously.
9. Remove the cork under water in the evaporating dish.
   Did any change in level of the water occur?

   What can you infer about the solubility of carbon dioxide?

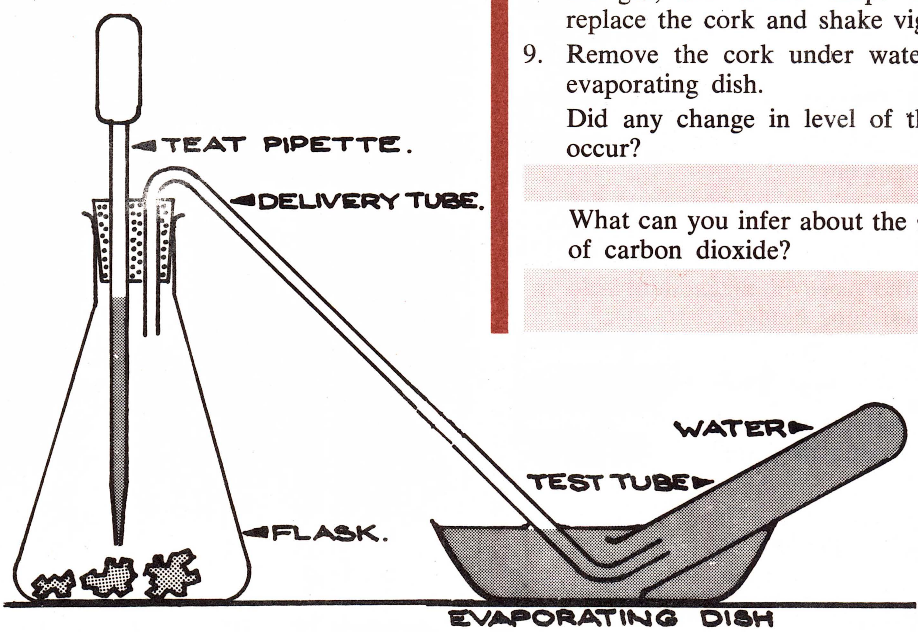


FIG 1.

10. Seal the test tube with your finger and remove the test tube from the dish and add 2 drops of litmus solution to the test tube.

A solution of carbon dioxide in water is

This is due to a reaction with water forming a weak acid, carbonic acid.

Write the equation for this.

11. Repeat the solubility test with another test tube of carbon dioxide but add a few drops of sodium hydroxide solution instead of water.

What happened?

Write the equation for the reaction.

What ions remain in solution as spectator ions?

You have carried out a reaction similar to this each time you have done the limewater test since limewater is the alkali calcium hydroxide.

What are the spectator ions when limewater is used?

Why does a precipitate form?

12. Plunge a lighted splint into the carbon dioxide in the preparation flask.

What happens?

13. Repeat with the other 25 cm^3 flask using the piece of magnesium held in your test tube holder.

(Avoid looking directly at the burning magnesium)

Two products should be visible. What do you think they are?

Write the equation.

Date	Some Bicarbonates	Exercise
Materials	test tubes delivery tube marble chips sodium hydroxide pellet	sodium bicarbonate (solid) hydrochloric acid barium chloride limewater

Procedure

Carbonates and bicarbonates are salts of carbonic acid H_2CO_3. Carbonates are called *normal salts* and bicarbonates are called acid salts.

A. Preparation of bicarbonates and carbonates

1. Place a pellet of sodium hydroxide in a test tube and add drops of water. Allow the solid to dissolve.
2. Generate carbon dioxide by adding dilute hydrochloric acid to a few small marble chips in a test tube.
3. Bubble the carbon dioxide through the sodium hydroxide solution for a few minutes.

   The solution remaining is sodium bicarbonate solution.

   Write the equation for the reaction.

4. Place 2 drops of the bicarbonate solution in a test tube and add 2 drops of barium chloride solution.

   What happens?

5. Boil the bicarbonate solution which has not been used.
6. Now add 2 drops of barium chloride solution.

   What happens?

   Boiling the solution converts the acid salt into the normal salt.

7. Place 5 drops of limewater in a test tube.
8. Recharge the carbon dioxide generating tube and bubble carbon dioxide through the limewater.

   What happens?

   Write the equation for the reaction.

9. Continue to pass carbon dioxide until the solution becomes clear.

   Write the equation for the reaction.

   The insoluble normal salt
   is first formed, and this is
   converted into soluble

10. *Keep this solution.*

B. The stability of bicarbonates

11. Place 2 drops of limewater in a test tube.
12. Place 3 spots of sodium bicarbonate in a *dry* test tube and heat strongly.
13. Remove a sample of the gas above the sodium bicarbonate with a teat pipette.

14. Bubble this gas through the limewater. What happens?

Write the equation.

What can you infer about the stability of sodium bicarbonate.

15. Divide the solution of calcium bicarbonate (retained in 10) into two equal parts.
16. Heat one part of the solution. What happens?

Write the equation.

What can you infer about the stability of calcium bicarbonate?

17. Pour the other part of the solution into a stock beaker. Allow this to stand for a week and then
Test the solubility of any residue.
What can you infer about the stability of calcium bicarbonate?

Date	The Hardness of Water	Exercise

Materials			
	resin ion-exchange column burner test tubes distilled water teat pipette	*Solutions:*	sodium carbonate sodium chloride sodium sulphate sodium bicarbonate calcium chloride calcium bicarbonate magnesium sulphate soap

Procedure

A. Hardness

1. Place 10 drops of distilled water in a test tube.
2. Add soap solution drop by drop until a lather forms on shaking.
3. Count the number of drops used.
4. Repeat using 10 drops of each of the solutions listed. Record your results in Table I.

What ions are present if the water is hard?

Temporary and permanent hardness

1. Place 10 drops of calcium bicarbonate and calcium chloride solutions in separate test tubes.
2. Gently boil each solution, being careful not to lose any solution.

TABLE I

Liquid	*No. of drops of soap*	*Appearance of solution*	*Hard or soft*
distilled water			
sodium chloride			
sodium sulphate			
calcium chloride			
magnesium sulphate			
sodium bicarbonate			
calcium bicarbonate			

TABLE II	*Calcium bicarbonate*		*Calcium chloride*	
	boiled solution	*solution not boiled*	*boiled solution*	*solution not boiled*
no. of drops of soap solution				

3. To each solution add soap solution drop by drop, shake and count the number of drops used before a lather forms. Record in Table II.

Hardness which is removed by boiling is called hardness. It is caused by calcium and magnesium ions which are associated in solution with ions. Hardness not removed by boiling is called hardness. It is caused by calcium and magnesium ions which are associated with ions.

Write the equation for the effect of heat on a bicarbonate.

Softening water

1. Place 10 drops of calcium bicarbonate, magnesium sulphate and calcium chloride solutions in separate test tubes.
2. Add 2 drops of sodium carbonate solution to each.
What happens?

3. Now count the number of drops of soap solution needed to form a lather. List in Table III.

What can you infer from this?

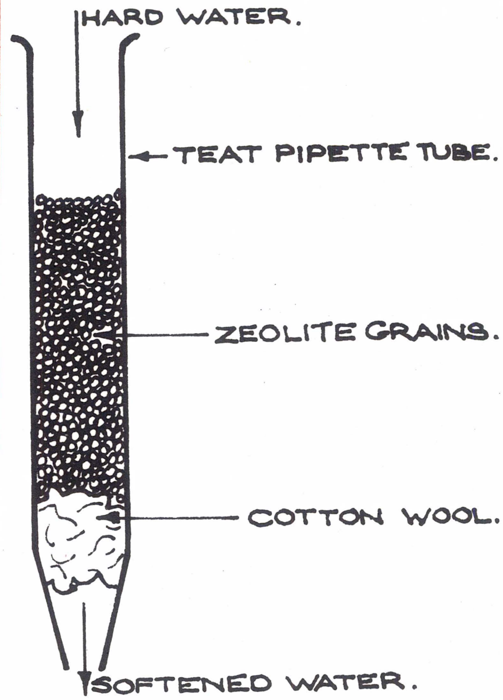
Suggest why sodium carbonate is known as washing soda.

TABLE III	*No. of drops of soap*	
	unheated	*heated*
Calcium chloride		
Magnesium sulphate		
Calcium bicarbonate		

Write the equation for the reactions.

Ion-Exchange

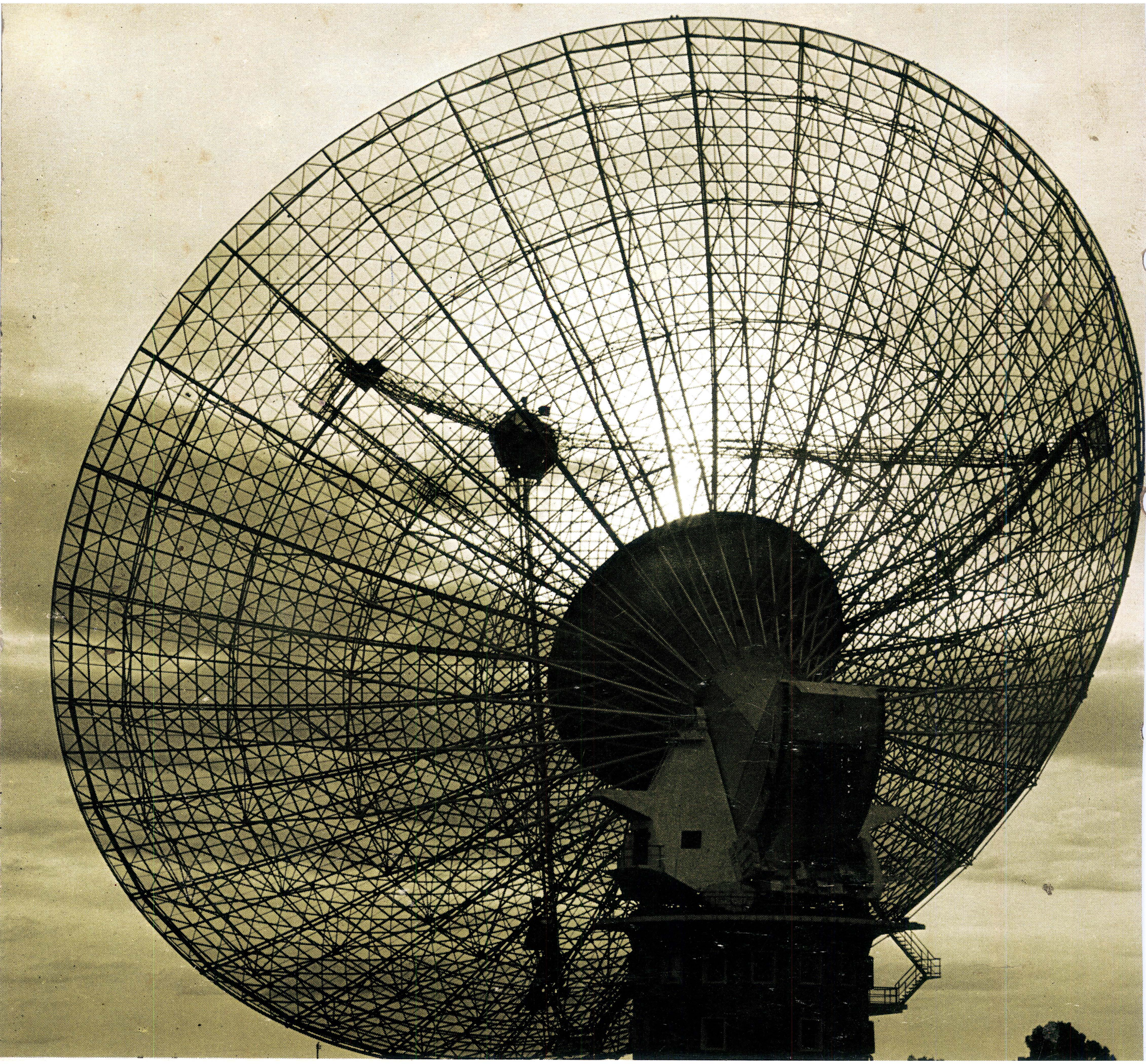
1. Set up an exchange column as shown.



2. Run a sample of hard water through the resin into a test tube.
3. Measure out 10 drops of the solution into another test tube.
4. Count the number of drops of soap solution used to produce a lather.

TABLE IV hard water sample	*untreated*	*treated*
no. of drops of soap solution		

What can you say about the treated water?



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